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THE CORONATION

WITH the Coronation the scientist, as such, may appear to have but little concern. Like his fellow citizens, he may be profoundly moved by the pageantry and the tradition to which the Lancaster Herald directed attention in a recent discourse at the Royal Institution, the substance of which is reproduced on p. 948 of this issue. Nor will scientific men be backward in responding to the appeal of the occasion for re-dedication to service to the community in the Commonwealth with which the Queen and her husband have already become so inspiringly associated. Save, however, for those whose interests lead them to probe more closely into the origins of ritual and ceremony and their meaning for the continuity and the structure of society, the interest of men of science in the Coronation is essentially that of citizens rather than of scientists.

Nevertheless, there are reasons why the Coronation and what it represents deserve more than a passing thought from the scientist professionally. It is not simply that the pageantry and solemnity of the proceedings are brought to the ears and before the eyes of many more millions throughout the world than was possible even sixteen years ago, when George VI was crowned. Scientific advance—the astonishing miracle of science—has been the main factor that has made it possible for so many of the Queen's subjects to associate themselves so intimately with her in the very act of consecration and dedication, whereas before they had been limited to the manifestation of loyalty in the thronged processional streets or to viewing later the record of what was already a page of history. In the misgivings with which in some quarters the televising of the ceremony has been regarded, and the anxious debate which preceded that decision, may be sensed an appreciation that the impact of science on society has consequences and implications of which we are as yet only imperfectly aware. The very advances of which science is justly proud have themselves created fresh problems, often of unsuspected significance. The mind and outlook of society as well as its physical environment are being transformed, and the end is not yet apparent.

It would be surprising indeed if in such circumstances the minds of men and women did not turn with fresh and deeper interest to those ceremonies such as the Coronation which, by kindling loyalties and quickening tradition, seem to offer fresh hope of stability and of binding society together in an age when so much tends to erode its fabric. Nor is this all. Men of science are only too well aware of the extent to which, in country after country, the traditional freedom of investigation of the scientist, his right to pursue his investigations and inquiries wherever the disinterested search for truth may take him, has been challenged. The struggle for freedom of investigation and utterance which the nineteenth century deemed to have been won has been re-opened, and in circumstances often far more formidable to freedom than when Milton wrote his noble words in the "Areopagitica".

There are countries where science has at its disposal financial endowments vastly greater than those available in Great Britain, both for fundamental and for applied research. The universal tribute to the pre-eminence of British scientists in fundamental research might well remind us that in no other country does the scientist enjoy greater freedom of investigation and communication, despite all the invasions of that freedom by secrecy requirements arising out of considerations of national security, from which Great Britain, as also other countries, is not immune. So at this time the scientist might well reflect further whether there is not some connexion between that liberty and the nature of our whole system of government of which her gracious Majesty is the titular head.

Between systems of government and the spirit of the communities which they serve there is in fact a close, if intangible, connexion. The scientist never had more reason than to-day for appreciating that, while his professional activities are influencing the community more closely than ever, they are in turn conditioned by the spirit and outlook of the society in which he works and upon whom he depends for support. It is not simply that, to an increasing extent, even fundamental science depends upon public funds for support: the fields in which science can advance, and the rate at which the results of scientific advance are applied, are determined increasingly by public opinion. Indeed, in more countries than one it has become evident that there is real danger that scientific advance may be impeded by mass hysteria and misunderstandings amounting to what has been an antagonism which may constitute a definite anti-scientific trend.

It is in such circumstances that the amateur tradition of science is so important. Scientific advance has always owed much to the work of the amateur. That is still true to-day; and particularly science depends upon the help of the amateur in spreading an understanding and appreciation of what science is doing and the benefits it could bring to mankind. For this reason it is appropriate to recall, as Sir Arthur MacNalty does on p. 951 of this issue, the encouragement which the sovereigns of this realm have given to the pursuit of science and its teaching. The interest and understanding which Queen Elizabeth showed earlier this month at the Royal College of Surgeons was only the latest of a number of occasions on which she and her husband, the Duke of Edinburgh, have given encouragement which scientists, and perhaps especially it should be mentioned, the younger scientists, deeply appreciate and will ever remember.

Lastly, with a Sovereign who has herself shown her interest in science by accepting the fellowship of the Royal Society, the comparisons commonly being made between the present time and the first Elizabethan age cannot but stir the imagination of the historically-minded scientist. When the first Elizabeth ascended the throne, the founding of the Royal Society lay a full century in the future. Already, however, the discovery of America and the circumnavigation of the world had widened men's horizons, and the new learning, notably through the work and teaching of the Oxford 'humanists', More, Grocyn, Colet and Linacre, had started a ferment in men's minds which led in due course to Bacon's "New Atlantis" and to Newton.

No more than the first Elizabethans can we yet discern the new age that is waiting to be born. During the past four centuries, the limits of the physical world have been well-nigh explored. Save for Everest and the increasing mastery of the air, the feats of geographical exploration seem to have been accomplished, and it is with the world of the minute that the future seems likely to be most intimately concerned, whether we think in terms of nuclear research leading to the atom bomb or industrial power, or the way in which the electron microscope and other new tools are laying bare the structure of living tissues. Wherever that may take us, it is increasingly clear that not in the physical world will man find the wisdom and understanding that will enable him to face the future with courage and confidence. The foundation of society in the new Elizabethan age is to be found in the same moral and spiritual values that inspired the greatest of our forbears of that earlier age. The solemnity of the Coronation should take our minds back to that central truth, and as we pledge our loyalty to the Queen who is to be crowned on June 2, we should remember also that in such loyalty and in the respect for and clearer understanding of human values lies the condition both of scientific advance and of social well-being and order.

INTERNATIONAL TABLES FOR X-RAY CRYSTALLOGRAPHY

International Tables for X-Ray Crystallography
(Published for the International Union of Crystallography.) Vol. 1: Symmetry Groups. Edited by Norman F. M. Henry and Kathleen Lonsdale. Pp. xi+558. (Birmingham: Kynoch Press, 1952.) 105*s*.

AT a conference in Zurich in 1929 an international group of X-ray crystallographers met to work out the plans for a standard set of tables on space groups and of functions and data needed in practical crystal-structure analysis. The need for such tables arose in the minds of all those who were authors or prospective authors of books on structure analysis. At that time the application of space-group theory had become an accepted practice; furthermore, experimental methods had been standardized and corrections devised for obtaining the most accurate data. In a text-book, therefore, the author had either to include a great volume of already published tables, or to put up with the fact that his book could not be of practical use. Besides, different formalisms and nomenclatures were likely to spread and become firmly established in the schools of the various countries, and this was apt to lead to a great complication of the international literature. The establishing of a single plan for the tables required some sacrifice of pet ideas on the part of each of those who took part in the planning, but the result of the conference and of the subsequent work of the various schools, the "Internationale Tabellen zur Bestimmung

von Kristallstrukturen" (Borntraeger, Berlin, 1935; referred to later as "Tab.'35"), have fully justified the advantages of the give-and-take then exercised. Not only have these tables in the original edition and in a war-time photo-offset re-issue done great service in all X-ray analysis laboratories as well as in the teaching of students, but they have also led to a great saving of effort by the acceptance of standard symbolism and methods.

In the twenty years that have passed since the preparation of "Tab.'35" enormous progress has been made in the development and application of new methods of crystal-structure determination, such as the development of new instruments (Buerger precession camera, Geiger counter technique), computing techniques (punched card methods) and theoretical methods (phase inequalities, statistical detection of symmetry elements, Fourier refinement methods). It seems natural that a full re-edition of such tables would be preferable to a minor revision. Besides, the ground had meanwhile been prepared for an easier co-ordination on an international scale than was possible by individual initiative in 1929. The International Union of Crystallography at its very foundation (London 1946, Harvard 1948) set up a committee to prepare a modern set of tables, and, thanks to the untiring activity of its chairman, Prof. Kathleen Lonsdale, the committee has now published the first of the three volumes which will form the complete work.

To start by the 'habit', the volume of five hundred pages is beautifully published for the Union of Crystallography by the Kynoch Press. Paper, binding and print are an impressive sample of craftsmanship, and no misprints have been noticed. The layout, especially for the simpler space groups, is lavish, with an impeccably white lower half of the page inviting one to scribble down notes. The price is kept low by subsidies which the Union received from the United Nations Educational, Scientific and Cultural Organization and from United States sources through the United States National Committee for Crystallography.

Vol. 1 of "Tab.'52" presents the symmetry groups in fundamentally the same way as Vol. 1 of "Tab.'35". The bulk of the volume is formed by the description of each of the 230 space groups. Most of the figures of "Tab.'35" have been taken over; changes had to be made in cases where a more extended description was given, for example, in referring rhombohedral groups to hexagonal axes. The figures for cubic space groups have been omitted. Now it is true that in the cubic system figures are necessarily more schematic than in systems where the presence of at least one singular direction facilitates the orientation; yet I must confess that I feel rather lost without the neat figures of "Tab.'35" by which M. Mauguin found an acceptable solution to an intricate problem of spatial representation. Co-ordinates require careful reading, whereas the diagrams give at a glance a vivid impression not only of the equivalent positions but also of the right- or left-handedness of the surroundings of each equivalent atom.

A major change from "Tab.'35" is the partial separation of the space-group descriptions in physical space from the equivalent in Fourier space: the structure factors are collected for all space groups in Table 4.7 (150 pages), whereas the 270 pages of space-group description, forming Table 4.3, after listing the co-ordinates of equivalent points, do not go beyond a listing of the absent reflexions, omitting previously listed information (for example, subgroups) which was considered of minor practical value. While the present separation and curtailment may not inconvenience the practical worker, yet the old arrangement had the unquestionable advantage of offering at one place a complete dual description of each space group in crystal and in Fourier space.

In the monoclinic system the twofold symmetry axis is traditionally taken as the *b*-axis; this orientation is generally accepted throughout the older crystallographic and mineralogical literature. On the other hand, a unique axis is taken as the *c*-direction in all other crystal systems, and the derivation and handling of space groups is slightly more unified if this convention is also adopted in the monoclinic system. The authors of "Tab.'52" have tabulated monoclinic groups in both settings. It is to be hoped that the users of "Tab.'52" will be aware of the recommendation of the Stockholm Assembly (see *Acta Cryst.*, **4**, 569; 1951) that "the use of the *c*-axis as the unique axis is acceptable where there is a special reason for this setting, in which case the reason should be stated". Normally, therefore, the second setting should be used in "Tab.'52" so as to avoid a clash with the very extensive existing literature.

Among the novel material of the space-group tables a list of the symmetry properties of $|F|$ must be mentioned. For $P4_3$, for example, this takes the form:

$$|F(hkl)| = |F(\bar{h}\bar{k}l)| = |F(h\bar{k}\bar{l})| \neq (F(\bar{h}kl)|\,; \qquad |F(\bar{h}kl)| = |F(h\bar{k}l)|.$$

This statement is far from expressing completely the symmetry properties of $|F|$. What about $|F(hkl)| = |F(\bar{k}hl)|$, the result of the fourfold axis? Throughout the reported symmetry relations, the order of the indices (hkl) in the argument of F is preserved; in other words, only the symmetry of $|F|$ which is caused by twofold axes or x, y, or z reflexion planes is listed. On the other hand, the obvious centro-symmetry of $|F|$ is repeated for every single space group. The extensive introductory note of the structure-factor tables offers no help in understanding the principle of this selective listing of the symmetry of $|F|$.

Some tables of "Tab.'35" have been omitted as being of minor practical value: these are mainly the collective tables on lattice complexes, which formerly occupied twenty-six pages, and the list of lattice complexes, non-generating symmetry elements and sub-groups which were provided under the heading of each space group. Part of this material is offered in a condensed form in Table 5.2 (three pages) on sub- and super-groups of the space groups. References in the explanation of this table might well have included "Tab.'35", where a full list is to be found.

The progress in methods of using experimental data is reflected in the inclusion of the expressions for Fourier synthesis, that is, the explicit form of the Fourier series for $\varrho(x, y, z)$ in each space group. This important information was not contained in "Tab.'35" and was first published in Prof. Lonsdale's "Structure Factor Tables" (George Bell and Sons, Ltd., 1936). Also new are Tables 5.3 (space-group determination by methods outside the Friedel law) and 5.4 (inequalities arising from symmetry elements), both occupying about one and a half pages. The latter

lists the special forms of Harker–Kasper inequalities in the presence of symmetry elements; the former section is mainly a description of the statistical treatment of intensities along the lines inaugurated by Dr. A. J. C. Wilson.

Further welcome additions are tables on the space groups of lower dimensionality, namely, the two linear and the seventeen planar groups (that is, the two groups on a line and the seventeen groups in a plane). These are important for the classification of the symmetry of projections of space groups or of sections through space groups, and have been fully tabulated. Of perhaps greater physical importance are the groups with one translation (seven in the plane (borders), thirty-one in space) and the eighty groups (nets) with two translations in which the particles are allowed to lie in three-dimensional space (for example, a woven tissue). These have been mentioned but not tabulated in the note on p. 56; more general knowledge of these groups seems desirable, and inclusion in the present volume would have greatly improved their accessibility.

The text explaining the tables and their use is clearly and carefully written; it offers more explanation than that of "Tab.'35". Altogether, one notes the tendency to facilitate the use of the tables by workers who have little more than a general idea of space groups. This is an acknowledgment of the fact that this rather mathematical tool is being used to an ever-increasing extent by chemists and biologists whose main training cannot include the details of an intricate mathematical theory. Examples of the use of the tables are often given, and I agree wholeheartedly with this; on the other hand, I feel strongly that a volume of tables should not attempt to teach methods, like a text-book. Neither is it the place for a historical article surveying the development of space-group theory and crystal-structure analysis (pp. 1–5). A very welcome innovation, however, is the last table, Table 7 (five pages), which is a dictionary of crystallographic terms in English, French, German, Russian and Spanish; this in a way replaces the trilingual text of "Tab.'35". The rather embryonic dictionary seems to be limited to terms occurring in the text of Vol. 1, but it is a good start for a more general dictionary of terms likely to be encountered in papers on structure analysis. Some rather unusual German terms and others which have been omitted have been noted: for 'Habit' *Tracht* should have been given, since *Habitus* is easily recognizable. The expression *Hydrostatischesmodul* (*sic*) for *Kompressionsmodul* is unlikely to be encountered. The use of *Stab* for line in *Reflexionsstab* and in *Symmetriestab* is new to me, but may be a modern development. Thermal vibration is usually *Wärmeschwingung*, and the correct rendering of 'moving-film method' would be *Goniometermethode* and not the impossible *bewegend-Film-Methode*.

The foregoing criticism of detail should not detract from the fact that the authors and in particular the editors, Dr. N. F. M. Henry and Prof. K. Lonsdale, have performed a splendid and most unselfish service to the large group of crystallographers who benefit by the use of such tables. The new work is an adaptation of the results of theory by experimentalists of long standing for the benefit of experimentalists, and is based on the experience obtained with the older set of tables. Some innovations are obvious improvements, others appear questionable, but only the prolonged use of the tables will bring out fully their virtues and their foibles.

P. P. Ewald

ADVANCES IN AGRONOMY

Advances in Agronomy

Prepared under the auspices of the American Society of Agronomy. Vol. 3. Edited by A. G. Norman. Pp. x+361. (New York: Academic Press, Inc., 1951.) 7.80 dollars.

MANY sciences now have their annual volumes of "Advances", consisting of summaries of particular sections of the subject written by specialists. Agronomy, the study of crop production and soil management, began to be so surveyed in 1949 by the American Society of Agronomy with authors working under Dr. A. G. Norman as editor. The third volume has now appeared. In so wide a field there is abundant choice of material, and almost any subject considered over an area as varied in its conditions as the United States presents a formidable array of data, with the result that most of the contributions are necessarily lengthy and carry numerous references to the literature. Papers such as that on the subsoil, and one dealing with the chemistry of soil potassium, are not, nor are they intended to be, easy reading. The student has to work for his information, but the material is clearly set out to enable him to do so.

In addition to the two papers mentioned above dealing with various aspects of the soil, two deal with legume and herbage plants, two with systems of management of soil conservation and irrigation, and one with a disease problem—the control of soil nematodes. Vol. 3 also contains an excellent survey of recent changes in British agriculture by J. A. McMillan, of the National Agricultural Advisory Service.

In evaluating soil the surface soil commonly receives more attention than the subsoil. It is true that as a seat of soil nutrients the subsoil is generally, though not always, much inferior to the surface, but its properties in respect of root penetration and drainage are of great importance. In the article on this the author deals with the physical properties, clay minerals and fertility-levels of subsoils in the broad soil classes of the United States and discusses at length the characteristics of the various subsoil pans that occur. Interesting sections deal with the difficult and sometimes unsolved problems of the management of subsoils exposed by soil erosion, and the bad effects of subsoil compaction caused by the use of heavy tractors, especially in wet conditions.

A comprehensive paper on soil conservation summarizes the position reached and scientific problems raised by work carried out under the large government schemes that have operated since 1933. The problems are not entirely technical; in fact the most obstinate ones arise from the fact that no farmer takes kindly to alterations in his system which cost money, involve learning fresh skills and may, at the outset at any rate, result in lower returns.

Rather similar treatment is accorded to the subject of irrigation and soil research. The emphasis here is on the need for complete and reliable scientific information derived from both laboratory and pilot farms before a big scheme is launched. This applies to surface irrigation in the arid areas and also to overhead supplemental irrigation in wetter districts. The modern factorial field experiment is essential in studying the inter-relation of fertilizers, water supply and cultivations. The effect of big schemes on the water economy of whole districts needs to be looked into.

A very readable article on chemical treatment of the soil for nematode control shows that soil fumiga-

tion has got past the purely experimental stage; the author estimates that fumigants sufficient for a hundred thousand acres were produced in 1950, the chief being ethylene dibromide. As yet, the process is only warranted for high-value crops, and the eelworm population is checked rather than wiped out.

THE BIRTH OF NEO-POSITIVISM

The Vienna Circle

The Origin of Neo-Positivism; a Chapter in the History of Recent Philosophy. By Prof. Victor Kraft. Translated from the German 'Der Wiener Kreis' by Arthur Pap. Pp. xii+209. (New York: Philosophical Library, Inc., 1953.) 3.75 dollars.

HOWEVER rapidly philosophical climates may change, and whatever may prove to be the capricious nature of their characteristic cycles, there are certain epochs which will always stand out. One of them is assuredly that of the Vienna Circle. Postponing for the moment a more detailed consideration of its *Lebenslauf*, it is meanwhile worth recollecting that to many scholars in Great Britain it was always "Der Wiener Kreis", a sure token of affectionate regard; and this in spite of a healthy determination to be the candid friend, avoiding like the plague all semblance of merely polite approval. Thus, as the author says, in Britain and in the United States its purpose found understanding and its tenets secured respect. Not so, however, in contemporary Germany, wherein many cross-currents (not all of them wholly fortuitous) combined to make very heavy weather for the evangelists of neo-positivism.

It is essential to see Prof. V. Kraft's book against such a background. Further, one may dislike the Circle's particular criterion of verifiability and its rather facile (and over-frequent) use of the adjective 'meaningless'—in fact, much of the stock-in-trade—and yet agree what great things it has accomplished. For this is a close-up view, not so much of the creed as of the people who fashioned it, and who passionately believed in it. For those reasons alone, a version in the English language is welcome. Would that—even allowing for its production on the western side of the Atlantic—it was a better version. Epistemological German is notoriously hard to translate, and even harder to make live; but *ebenso*, some of the text as it now appears is far from lovely, and moreover, many of the blemishes upon it are utterly needless.

The core of the volume consists of two long sections: logic and language, and empiricism. As might be expected, these form a commentary—and a very just one—upon the work of Carnap, Wittgenstein and their colleagues, on one hand, and of the critics on the other. The basic division is between the 'logic of science' and the special sciences. The latter are held to be concerned solely with questions of fact, to be validated by experience. Epistemology must have nothing to do with such things; its task is to deal with the logical structure of scientific knowledge. At the same time, philosophical method itself is required to conform to scientific principles.

Towards the end, we find a noble attempt to face up to the axiological import of the Vienna Circle's outlook. Obviously, it was heavily conditioned by a reaction against German metaphysics. Yet, conceptual poetry and even personal wisdom are not denied: upraised on their own pedestal they stand, but qualified as subjective and unverifiable in that they lack universal validity, and therefore the title, to represent knowledge.

Nobody can rightly quarrel with such a statement, the result of years of labour, thrust and counter-thrust by honest men engaged in the quest for truth. But they themselves would be reluctant to claim that the last word had been spoken: the Circle has been disrupted and its members scattered, some luckily to find shelter in calmer waters. Down the years, too, death has taken a heavy toll, but the search goes on, at once courageous (sometimes perhaps almost foolhardy) and relentless. F. I. G. RAWLINS

BENJAMIN THOMPSON, COUNT RUMFORD

An American in Europe

The Life of Benjamin Thompson, Count Rumford. By Egon Larsen. Pp. 224+28 plates. (London: Rider and Co., Ltd., 1953.) 15*s*. net.

THIS book is described by the publishers as "the first popular yet authoritative biography" of Benjamin Thompson, Count Rumford, and its publication was timed to coincide with the bicentenary in March 1953 of his birth. It is a very readable short account of his life and activities, or certain aspects of them. Mr. E. Larsen has been at great pains to collect information in the various places where Rumford lived and worked, and we are indebted to him for some new and interesting particulars—for example, the information on the laying out and subsequent history of the English garden in Munich and that on the house at Auteuil which was Rumford's last home. Some of the illustrations, which are good, are from photographs by the author.

It is not a book to go to for an estimate of Rumford's achievements as a man of science. The references to his fundamental researches on heat are scanty, and the author has not attempted anything in the nature of a connected account of his scientific work. There is a fuller and more satisfactory treatment of his measures of reform in Bavaria, his work for the poor in Munich, and the methods of fuel economy and designs of stoves and fireplaces which he introduced in his workhouses and military establishments. Emphasis is rightly given to his pioneering efforts in the application of scientific principles to purposes of this kind.

A chapter is devoted to his later period in England and his activities in connexion with the founding of the Royal Institution. At the end of the book a well-chosen series of extracts from Rumford's essays, indicating the varied nature of his interests, extends to some forty pages.

It is, however, on a personal and biographical thread that this book hangs, and if the treatment of such matters as Rumford's relations with his daughter and with his second wife, the widow of Lavoisier, is somewhat journalistic, it is none the less interesting. Biographical writing on Rumford begins with Ellis's invaluable "Memoir", published in 1876, and, although much has been written since, the character of the man remains in certain respects somewhat shadowy. In his more personal affairs he covered up his tracks, and the impression persists that the full story of his life has yet to be written.

T. MARTIN

TRADITION AND THE CORONATION*

By ARCHIBALD G. B. RUSSELL, C.V.O.
Lancaster Herald,
College of Arms, Queen Victoria Street, London, E.C.4

THE solemnity of the coronation of kings and queens has from the earliest days taken a supreme place in the imagination of the people. How much more so is it the case to-day, since it has come to typify in a very real sense the unity of the British Commonwealth of Nations under the Crown.

Westminster has been the scene of the coronation since it was chosen by William the Conqueror as the place for his own coronation. The earliest Christian coronation of an Anglo-Saxon king of which record remains is that of Egfrith, whom his father, Offa, King of Mercia, had crowned as his successor in 785†.

In the tenth century it was usual for coronations to take place at Kingston-on-Thames. It was on the 'King's Stone', which is still treasured there, that kings were crowned. The use of a sacred stone for this purpose follows a very ancient tradition which was later carried on with the Stone of Scone down to the present day.

Westminster Abbey as it now stands was in greater part built under the direction of King Henry III in the middle of the thirteenth century. It replaced two previous churches on the same site. Its immediate predecessor was the church built by Edward the Confessor and consecrated in 1065, which replaced the original Saxon church and in which the Confessor himself was buried. It was in this church that William the Conqueror and his successors were crowned. It was part of the original plan that the church built by Henry III should be used for coronations, as is evidenced by the unusual feature of the space left between the Choir and the High Altar. It is upon a raised platform erected upon this space, known as the Theatre, that the greater part of the coronation ceremony takes place.

A manuscript of the life of King Edward the Confessor in the Cambridge University Library contains two beautiful drawings, in each of which the artist seeks to convey the impression of religious exaltation. In one of them the King is being anointed with the holy oil. It is this King who is venerated as a national saint, and to whose kingly virtues we owe the greatness of the Palace and Abbey of Westminster. The other drawing depicts the coronation of Queen Edith, his consort.

In the coronation scenes which decorate the exterior walls of the King's Chantry Chapel in Westminster Abbey there is a carved group representing the coronation of King Henry V. It is at once a historical document and a valuable work of art. The crown is being set upon the King's head by the Archbishop of Canterbury and the Abbot of Westminster. The then Abbot was the famous William of Colchester, the 'grand conspirator' of Shakespeare's play. The monumental grandeur of the presentation and the noble pattern of the Royal Arms which accompanies it give it a place as a work of sculpture among the most moving of any produced in Britain. The majestic stillness of the central figure of the King is superbly enhanced by the upward movement of the flanking figures.

The Banquet

Of the services referable to the banquet which formerly succeeded the coronation, in the Great Hall at Westminster, that done by the King's Champion surpasses all others in its romantic appeal.

This privilege has been in abeyance since the discontinuation of the banquet, which was last held on the occasion of the coronation of King George IV. The service is associated with the ownership of the Manor of Scrivelsby in Lincolnshire, which was held from very early times by the family of Dymoke. In lieu of this service, the Union Standard will be carried by Captain J. L. M. Dymoke at the forthcoming coronation.

A lively study of the Champion appears in a tinted drawing accompanying the pedigree of Dymoke in the original Visitation of Lincolnshire of 1564 at the College of Arms. It is the likeness of Sir Edward Dymoke of Scrivelsby, who was Champion at the coronations of King Edward VI, Queen Mary I and Queen Elizabeth I. His fancifully decorated armour of astonishing richness and the superb trappings of the horse are characteristic of the first Elizabethan Age. He is depicted at the dramatic moment when, after issuing his challenge and offering to combat with the "false traitor . . . who shall deny or gainsay our sovereign lord the King", he is about to fling down his gauntlet.

The Earl Marshal

The Duke of Norfolk, who holds the hereditary office of Earl Marshal of England, is responsible for the whole of the arrangements for the coronation, with the exception of the church liturgy, which is ordered by the Archbishop of Canterbury. The Duke holds hereditary office, granted to his family by King Charles II in 1674, who conferred it on Henry Howard, Earl of Norwich, afterwards Duke of Norfolk, and his heirs.

The office derives from that of Marshal of England, which was one of the five great offices of state. The earliest holder of the office of whom we have record was one, Gilbert, whose descendants adopted the surname Marshal in virtue of their office. Later it passed to the Bigods and to the Mowbrays and afterwards to the Howards, though it did not actually become hereditary in their family until 1674.

Charles II, in his declaration of the authority of the Earl Marshal, described him as "the next and immediate Officer under Us for determining and ordering all matters touching Arms, Ensigns of Nobility and chivalry", and the officers of arms as "Ministers subordinate to our said Earl Marshal".

The Officers of Arms

The Kings, Heralds and Pursuivants of Arms who assist the Earl Marshal in the coronation preparations

* Substance of a Friday Evening Discourse delivered at the Royal Institution on April 24.

† For certain of the historical data I am indebted to the several publications of Mr. Lawrence E. Tanner, keeper of the Muniments and Library, Westminster Abbey.

and who take part in the Abbey processions have also certain other duties to perform on the occasion. Among these are the handing over of the canopy to the Knights of the Garter who hold it over the Queen for the anointing, and the leading up of the senior peer of each degree to pay homage to Her Majesty. Scottish Heralds are also present, headed by Lyon King of Arms, and Ulster is now represented by Norroy and Ulster King of Arms.

Officers of Arms are known to have been in attendance at coronations from the time of that of King Henry IV, and it may, I think, be assumed that they did so at an earlier date.

The tabard which they wear on all state occasions is probably the most ancient ceremonial garment still in use, dating back to the second half of the fifteenth century and deriving from the court dress of that period. The tabards of the Kings of Arms are of velvet, those of Heralds satin, and those of Pursuivants damask silk.

On the death of the Sovereign the accession of the new Monarch is proclaimed by one of the Officers of Arms at four different centres in London. At a later date the coronation is proclaimed by the same four Officers at the same places.

The Officers of Arms are appointed by letters patent under the Great Seal of England. They are, under the Earl Marshal, responsible for the granting of arms, the marshalling of state ceremonies and other duties. The coronation is, of course, by far the most important of the state ceremonies with which they are concerned.

Sir Robert Vyner

Sir Robert Vyner, who was responsible for making nearly all the items of the present Regalia to replace those destroyed at the Commonwealth, began his career as a goldsmith as the apprentice of his uncle, Sir Thomas Vyner, who served the office of Prime-Warden of the Goldsmiths' Company. Sir Robert was born in Warwick in 1631, and in 1661 he received a grant of the office of 'King's Goldsmith'. Like his uncle, he served as Prime Warden of the Goldsmiths' Company. He was on intimate terms with Charles II, and made the Regalia for Charles's coronation at a cost of more than £30,000. He died at Windsor Castle in 1668 and was buried at St. Mary's Woolnoth, Lombard Street, London.

St. Edward's Staff

St. Edward's Staff was in early times delivered into the Sovereign's hands on entering the Abbey. It is now borne in the procession and this time will be carried by the Earl of Ancaster. The present Staff is part of the 1661 Regalia. The original, which was one of the relics of St. Edward, was a long iron-shod sceptre, and was reputed to contain a piece of the True Cross. The present Staff is surmounted by a golden orb, and the foot is tipped with steel.

The Maces

The two Maces were made by Sir Robert Vyner for the coronation of King Charles II. The heads are divided into four panels, each containing an emblem surmounted by a crown, and representing the constituent elements of the United Kingdom. Above is an arched crown, on the rim of which are alternate crosses and fleurs-de-lis. The crown is surmounted by an orb and cross. The Maces are carried by the Serjeants-at-Arms.

The Coronation Chair

The Coronation Chair was made for King Edward I, and was designed to hold the Stone of Scone which he removed from Scotland in 1296. The chair is of oak and was completed in 1300–1. It has been used for all coronations since that of King Edward II.

The back of the chair was originally painted with a seated king. Few traces of this now remain, and much of the original enrichment of gold and colours has perished. A superb early fourteenth century illuminated manuscript in the library of Corpus Christi College, Cambridge, portrays the Chair as it appeared not long after it was made. In this the four lions now supporting the Chair are absent, so presumably these were a later addition. The Chair, which has suffered much in the passage of time, is a rare example of the cabinet work of its day, and is probably to be regarded as the most venerable object associated with the coronation.

The Stone of Scone is first heard of in the thirteenth century, when it was preserved in the Abbey of Scone and was used in the consecration of Scottish kings. It is of reddish-grey sandstone, and was probably quarried in the neighbourhood of Scone. It has been identified in legend with the stone upon which Jacob rested at the time of his vision of the Ladder.

The Recognition

The coronation ceremony is initiated by the act of Recognition. This is a survival from the remote past when the choice of a sovereign rested upon an electoral basis.

The Oath

The Recognition is followed by the Oath. The form of the Oath has from time to time undergone revision from the fourteenth century onwards. The latest substantial alteration followed the reign of James II, who was a Roman Catholic, and at the coronation of King William and Queen Mary it was drastically changed with the view of ensuring the maintenance of the Protestant faith. A further innovation introduced at that time was the presentation to the Sovereign of the Bible as "the most valuable thing that this world affords".

The Anointing

In accordance with ancient tradition, it is with the anointing of a Sovereign with oil, rather than the actual crowning and the investiture with the Regalia, that the climax of the coronation ceremony is reached. The Monarch has been held in the past to assume a mixed personality of a semi-sacerdotal character. For Melchizedek, the priest-king, has remained through all time the type of kingly perfection ; in fact, the name may mean 'kingly righteousness'. The antiquity of the rite of the anointing of kings is recalled in the anthem which is sung beginning "Zadok the Priest and Nathan the Prophet anointed Solomon the King".

During the Anointing a canopy is held over the Queen by four Knights of the Garter. She is thus nearly concealed from view during the rite in view of its secret and mystic character.

The Ampulla is an eagle of gold containing the holy oil with which the Sovereign is anointed, the oil being poured out through its beak. It has been suggested that the Ampulla may be in essentials an original work of the time of Henry IV, the engraved decoration and the pedestal upon which the eagle is

mounted being the work of Sir Robert Vyner. Against this view is the fact that descriptions of the medieval Ampulla speak of it as a "dove of gold set with pearls and stones", while the existing Ampulla is stated to show no signs of ever having been set with precious stones.

The anointing Spoon escaped destruction in 1649, and is the oldest piece of plate used at the coronation. The bowl may have been re-worked by Vyner; but the stem, which is of exquisite workmanship, dates from the twelfth or early part of the thirteenth century. The Spoon is of silver heavily gilt, and ornamented with elaborate gold chasing, enamels and pearls. The bowl is engraved and is divided with a central ridge.

The Spurs

The ceremony of the Spurs follows the Anointing. They are brought from the Altar, and the Queen touches them with her hand, for they are emblems of knightly chivalry. They are of gold, with straps of crimson velvet, and were made for the coronation of Charles II.

Swords

Five ceremonial swords are borne at the coronation. The two-handed Sword of State is the most imposing. It is also carried at state openings of Parliament. Two other swords are known as the Pointed Sword of Spiritual Justice, or Second Sword, and the Pointed Sword of Temporal Justice, or Third Sword. The Queen's personal sword is known as the Jewelled Sword.

But historically the most interesting sword is Curtana. This is the Pointless Sword of Mercy. It was first mentioned by name at the coronation in 1236 of Queen Eleanor, wife of Henry II. The earliest representation of this Sword that I know of occurs in the portrait belonging to the Society of Antiquaries. This portrait has long been regarded as the likeness of Richard III; but I find it difficult to endorse this identity. I suggest that the sitter may in fact have been Henry Percy, fourth Earl of Northumberland, who, at Richard's coronation in 1483, is recorded as carrying "the pointless Sword, naked in hand, which signified Mercy".

The word 'Curtana' is doubtless derived from the Latin *curtus*, meaning shortened or curtailed.

Armillæ*

The coronation Stole, formerly known as the Armil, or Armilla, is not, strictly speaking, a stole. In religious ceremonies the Stole succeeds the Alb immediately; but in the coronation service it succeeds the Dalmatic, as it did in the eleventh and twelfth centuries, and it is still worn by deacons of the Orthodox Church. Its assumption at the coronation accordingly preserves the medieval custom which the Western Church has lost. It is a strip of material worn about the neck, having depending ribbons at its extremities which were there for a very particular purpose. In length, this strip should be an ell, that is, forty-five inches. Now, such a strip cannot be a stole, which is a vestment as long again. (The stole is intended to remind its wearer of the halter put about Christ's neck when on His way to be crucified.)

The appellation 'Armil' may be explained in the following way. At former coronations extending to that of Queen Elizabeth I, the Sovereigns were invested with wristlets (or bracelets) or armlets. Queen Elizabeth I is said to have worn 'garters' on the upper part of her arms. It is probable that this short strip of material placed about the neck of the Sovereign was not intended to be a stole but merely a means of preventing the slipping-down of the Armils which were attached to it by means of double ribbons at each extremity. Hence the name given to it, which either became confused in the course of time with the Stole or, after the Tudor period, made to serve both to restrain the armlets or bracelets or as a stole proper.

When the Regalia were made for Charles II in 1661 wristlets or bracelets were provided; but they have never been used. They may still be seen in the Jewel House in the Tower of London. It may be remarked that no words accompany the putting on of the Stole, which might support the view that it was only a means of restraining the armlets formerly worn. The last recorded occasion of the use of the Armillæ was at the coronation of Edward VI. It is not known whether they were used at that of Queen Mary I. They are not mentioned in the ceremonials of Kings James I and Charles I, and the pair that were in the Regalia were, in all probability, destroyed when the rest of the royal ornaments were broken up during the interregnum. Another pair was produced in 1661 for the coronation of Charles II, though they were not used, and they have not been brought forward at any succeeding coronation.

Armillæ were well known in the histories of ancient nations, and are mentioned in the Old Testament as having been worn by King Saul. They were the distinguishing marks of the king and warrior. At the forthcoming coronation, the Archbishop of Canterbury when investing the Queen with the Armillæ will say the prayer beginning: "Receive the Bracelets of sincerity and wisdom". These words appear in the order of the service recorded in the *Liber Regalis* of the fourteenth century.

The Armillæ, which were made in 1661, bear enamelled representations of roses, thistles, shamrocks and fleurs-de-lis. The pair that have just been made are of plain gold unadorned, except for a spiral floral design near the edges, and the snap, which is formed of a Tudor rose. They are the combined gift to the Queen of the Governments of Australia and of Southern Rhodesia.

The Orb

The Orb is a sphere of gold surmounted by a jewelled cross set upon an amethyst. It dates from King Charles II's coronation, and is a symbol of the sovereignty of Christ. A representation of the Orb appears upon a number of early Great Seals of British kings; but it is not mentioned in connexion with any medieval coronation.

The Ring

The Ring is put by the Archbishop on the fourth finger of the Queen's right hand. It is described as "the ensign of kingly dignity, and a defence of the Catholic Faith". It is set with a sapphire, with a cross in rubies on it. The ceremony of the investiture with the Ring goes back at least as early as the tenth century.

The Sceptre with the Cross

The Sceptre with the Cross, or Royal Sceptre, symbolizing power and justice, was made for the coronation of King Charles II. It is of gold, and is

* For the data relating to the Armillæ I am indebted to Mr. Gerald Henderson.

three feet long. The largest portion of the Star of Africa, cut from the Cullinan diamond, was inset in the head in 1911. Above is an orb of amethyst surmounted by a diamond and enamelled cross. Sceptres as emblems of kingly power are, of course, of great antiquity.

Rod with the Dove

The Rod with the Dove is the symbol of equity and mercy, the Dove being the emblem of the Holy Ghost. It is part of the 1661 Regalia. The gold staff is decorated with jewelled bands. The Dove, which in medieval times was of gold, is now of white enamel.

St. Edward's Crown

St. Edward's Crown in its original form was his own Crown taken from his grave in 1269. This was ordered by Cromwell to be destroyed with the other Regalia in 1649. The new Crown, much in its present form, was made by Sir Robert Vyner for King Charles II. It has been suggested, however, by Mr. Martin Holmes, that the original crown of St. Edward's was not in fact destroyed, and that it formed the basis of that made by Vyner.

The circlet, or rim, of the Crown, which is of gold, bears alternate crosses and fleurs-de-lis, and from the crosses rise the intersecting arches with, at the top, a globe surmounted by another cross, the whole being richly encrusted with precious stones.

The Crown, after the anointing, and the successive stages of the Investiture, is set upon the Queen's head by the Archbishop of Canterbury.

The Imperial State Crown

The Imperial State Crown was made for Queen Victoria, and has been slightly altered for subsequent coronations. In the front is the famous gem known as the Black Prince's Ruby. On the rim beneath it is another portion of the Cullinan Diamond. The sapphire in the cross surmounting the Orb at the top is traditionally believed to have come from the Confessor's ring; but it has been recut in modern times.

The Imperial State Crown replaces that of St. Edward shortly after the crowning has taken place.

SCIENCE AND THE SOVEREIGN

By Sir ARTHUR MacNALTY, K.C.B.

AT this time of Her Majesty's Coronation, it is appropriate to remember the encouragement which the sovereigns of this realm have given to the progress of science and its teaching.

The Middle Ages were intolerant to science. Roger Bacon, who made discoveries in optics and chemistry, had his books banned and was imprisoned for "suspected novelties"; Bolingbroke, mathematician and astronomer, "the greatest clerk of his age", was hanged and quartered as a wizard.

Then came the great invention of printing which gave to letters and to science the precision and durability of the printed page. Edward IV bestowed his patronage on Caxton, and Richard III during his brief reign encouraged the new invention.

In the reign of Henry VII the light and wisdom of the Italian Renaissance was brought to England by the Oxford "Humanists", Grocyn, Colet and Linacre. Henry VIII, whom Erasmus termed the "scholar king", was a highly accomplished monarch. He wrote excellent Latin, spoke French, Italian and Spanish, was musician, poet, naval architect, a master of ordnance, an amateur of medicine and a good mathematician. He delighted to converse with his learned subjects, appointed astronomers royal, and elevated medicine and surgery in status by founding the College of Physicians on Linacre's advice in 1518, and uniting the barbers and the surgeons as the Barber-Surgeons' Company in 1540, probably at the request of his serjeant-surgeon, Thomas Vicary. He also founded regius professorships of physic at Oxford and Cambridge. He first bestowed the honour of knighthood on two physicians, Sir Thomas Elyot and Sir William Butts. Edward VI knighted his surgeon, Sir John Ayleff. With royal approbation, Edward Wotton (1492–1555), of Padua and Oxford, and physician to Henry VIII, published the first systematic treatise on natural history, and William Turner, Dean of Wells, was the first Englishman to study plants scientifically. His "Herbal" of 1548 marks him as the father of English botany.

Queen Elizabeth I encouraged science. William Gilbert, president of the Royal College of Physicians, who founded the sciences of magnetism and electricity, was her physician and was awarded a pension by the Queen to enable him to conduct his researches, which Francis Bacon quoted in the "Novum Organum" as examples of the method of experiment. John Caius (1510–73), also a president of the Royal College of Physicians, the friend and pupil of Vesalius, was physician successively to Edward VI, Mary and Elizabeth. He wrote a treatise on the sweating sickness, and was a good classical scholar, anatomist and zoologist. Gesner, in a letter to Queen Elizabeth, termed him "the most learned physician of the age". She was a judge of scientific merit, and on her visits to Oxford and Cambridge was accustomed to preside over the disputes in the Physic Act for medical degrees. To James I, Francis Bacon dedicated his philosophy of inductive science which improved instructed thought and commended to the King the regeneration and restoration of the sciences.

The ill-fated Charles I was an enlightened patron of science as well as art and letters. William Harvey was his physician and the King showed the liveliest interest in his researches, being personally present, as Harvey records with pride, at a demonstration of the circulation of the blood and giving him facilities to use the deer in the royal parks for his pioneer work in embryology. King Charles also nominated Harvey as warden of Merton College, Oxford.

One of the greatest royal patrons of science was King Charles II. He founded the Royal Society in 1662, presented it with a silver-gilt mace, and presided at its inaugural banquet and at several meetings of the Society. He studied anatomy and chemistry, and his cousin, Prince Rupert, made several discoveries in chemistry. The King was always interested in new discoveries in the realm of science, as Pepys and John Evelyn tell us. King Charles "had yet skill to discover excellence and virtue to reward it", as is shown by the knighthoods he bestowed on Sir William Petty, the founder of the science of political economy, and the erudite Sir Thomas Browne.

The outstanding discoveries of Isaac Newton were recognized by William III, who appointed him master of the Mint in 1699, and by Queen Anne, who knighted him in 1702. All the four Georges encouraged science. George I is said to have boasted

of his two subjects, pre-eminent in science, Newton in England and Leibniz in Hanover. Sir Hans Sloane, president of the Royal Society and of the Royal College of Physicians, the founder of the British Museum, collector and naturalist, was created a baronet by George I, and George II made him his first physician. George III solved the difficulties of the Corporation of Surgeons by establishing the Royal College of Surgeons by royal charter, discussed the *Philosophical Transactions of the Royal Society* with Dr. Johnson, and bestowed a baronetcy on Sir Humphry Davy. The King incorporated the Royal Society of Edinburgh by royal charter in 1784. Sir Joseph Banks, president of the Royal Society for forty-one years, acted as the King's scientific adviser; it was he who directed the dispatch of collectors abroad for enrichment of the gardens at Kew. In the establishment of the Royal Botanic Gardens there the Crown has promoted the studies of botany and horticultural science. On Banks's advice, the Linnean Society was given a royal charter in 1802. George IV was liberal to science. In 1825, he founded two gold medals to be awarded annually by the President and Council of the Royal Society for important contributions to science. These medals have been continued by his successors. The King also granted a supplementary charter to the Royal College of Surgeons in 1822, and gave the site at a nominal rent for the new College of Physicians in Pall Mall, opened in 1825. In 1826, largely through the influence of Dean Buckland, the Geological Society was incorporated by royal charter.

It is, however, in the Victorian Age that science reached a position of fame and authority. This progress was achieved through the great discoveries made by Owen, Darwin, Wallace, Huxley, Lister and others; but the opposition and hostility the claims of science might have aroused were overcome or silenced by the support they received from Queen Victoria and the Prince Consort. Elected chancellor of the University of Cambridge in 1847, Prince Albert established the Natural Sciences Tripos in 1848, which gave a notable impetus to study and research. Aided by Prof. Owen, he urged a similar departure on Oxford which was soon afterwards followed. He initiated the Great Exhibition of 1851, which displayed the wonders of applied science to the public, and the invested profits of which supply grants to students of science to this day. The Prince's influence was available in every movement for promoting the interests of art and science, for developing the education and improving the material welfare of the nation. After his death, Queen Victoria continued his work.

This royal encouragement of science was promoted by the Queen's successors. King Edward VII was especially interested in social welfare, in the prevention of tuberculosis, and in medical research. King George V followed in his footsteps, although his modesty prevented him from accepting the presidency of the British Association, which King Edward VIII, when Prince of Wales, accepted, giving an admirable presidential address at Oxford in 1926. King George VI throughout his heroic reign encouraged science, and one of his last public acts was to open the new laboratories of the Medical Research Council at Mill Hill. Queen Elizabeth II has already shown her interest in science by accepting the fellowship of the Royal Society; and the Duke of Edinburgh, alike as president of the British Association at Edinburgh in 1951 and by his acceptance of the membership of other learned societies, shows an equal appreciation of the value of scientific work in this atomic age when so many new fields of endeavour open out before it.

That for centuries the natural sciences have received unfailing support from successive rulers of the United Kingdom has helped to smooth the onward path of those "who search out and study the secrets of Nature by way of experiment".

THE ADELIE PENGUIN

By Dr. W. J. L. SLADEN

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THIS summary of the breeding routine of the Adelie penguin (*Pucheramphus adeliæ*) differs in many respects from what has been written before. A full account of the work is in preparation (to appear in the forthcoming series, F.I.D.S. Scientific Reports). The study was made during two breeding seasons at Hope Bay, Graham Land, 1948–49, and Signy Island, South Orkneys, 1950–51, while serving with the Falkland Islands Dependencies Survey. The rookeries at Hope Bay and Signy exceeded 50,000 and 10,000 nests, respectively.

Evidence for the conclusions in this paper have been provided chiefly from marked and dissected birds. Approximately 1,300 Adelies were temporarily marked with paint, 338 banded with aluminium rings, many of which were also painted, and more than 800 dissected. The methods of marking penguins, including a new method using flipper rings, have already been described[1]. The large number of dissections was possible only because our 20–60 sledge-dogs, when at base, had to be fed on seal or penguin meat. Particular care was taken to cause no unnecessary waste of life.

Suggested Age-Groups

Adelies live among the pack-ice during the winter, returning to rookeries on land to breed during October–February. At Signy, in 1950, adults started to return during the first week in October; but the largest population was not counted until the first week in November (Fig. 1). Eggs were first seen on October 29, and fresh eggs were still being found on November 19, this variation and other differences in breeding efficiency being due, not only to variation among individuals, but also to age and breeding experience. I therefore propose to divide the population at the rookery into the following four provisional groups, hoping that it will be possible to confirm the first three later by studying birds of known age.

'Experienced' or 'Established' Breeders

These are probably four or five years old and more and have had at least one, and probably two, years breeding experience.

Successful breeders. Ten pairs of breeding Adelies were ringed at marked nests at Hope Bay in November 1946[2]. In 1948–49 twelve returned to the nest-sites where they had been originally ringed, and five of the original pairs were still intact. Two more were found at adjacent nests in November 1947 and again in November 1948. The remaining six were not found. These results suggest that established

pairs return each year to the same place and keep the same mates. Their behaviour also suggests that they can locate their old sites even under snow and can recognize their mates from the previous season.

The partners return from their winter quarters within a few days of each other; but if one of a pair comes back first, it will often keep company with another bird of the opposite sex until its true mate returns. A fight, male versus male or female versus female, may ensue in which the true mate usually wins. Should the mate of an established bird fail to return, the pair-bond may be established with its new partner.

Once arrived at the rookery, it was very rare for a breeding Adelie, either male or female, to return to sea until the nest of stones had been built and two eggs laid in it. During this period of about three weeks the pair were together; but as soon as the last egg had been laid, the female departed to sea to break her fast, leaving her mate to incubate alone. This normal routine (in which the sex of the males was confirmed by more than fifty dissections) could be upset by human or dog interference. Thus, if the male was killed before the female departed, she continued incubating for a few days but ultimately deserted when her weight dropped below about 3·5 kgm.

The male did not leave the rookery until his mate returned about two weeks later. While away, she regained most of the weight lost during her fast. Average fasting periods of seven marked males and females showed that the males fasted at least forty days, the females twenty-one (Fig. 2). A continuous fasting period of forty days by a bird is exceeded only by the male emperor penguin (*Aptenodytes forsteri*), which fasts for sixty days during incubation[3].

The weight of the females fell from 5–5·5 kgm. to about 3·5 kgm. and their blubber from 6–7 mm. thick to nothing. The males, starting at a higher level of 5·5–6 kgm., lost weight more gradually, reaching about 3·5 kgm. after their fast, when their blubber had diminished from 7–8 mm. thick to nothing. Males were at sea for about two weeks and

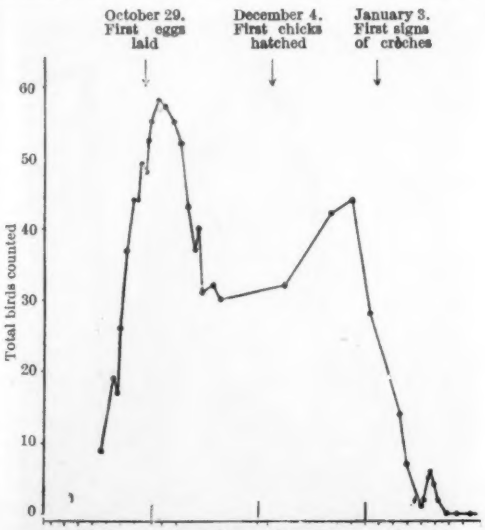

Fig 1. Population of a small colony at Signy Island, 1950–51, to show typical fluctuations during the breeding season

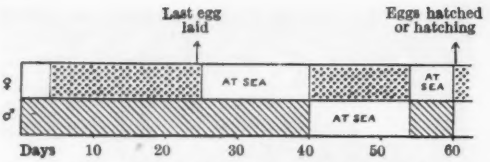

Fig. 2. Diagrammatic nest-history up to hatching of eggs made from the averages of seven males and seven females ringed at Signy Island on October 17 and 18, 1950. (Note: the first birds observed back at the rookery were seen on October 8, so the first fasting periods may be slightly longer than stated.) Male fasting periods at nest (hatched); female fasting periods at nest (dotted)

came back, having regained most of their lost weight, to relieve the females on the eggs, who left again for a short period. When they returned, the eggs were usually hatched or hatching (early and mid-December). The average incubation period was thirty-six days.

The parents shared care and feeding of chicks until they were large enough to be left alone. 'Crèches' were then formed in which the chicks congregated together in groups of a hundred or more, presumably for additional protection from the skua (*Catharacta skua*). By marking birds during both years of study, it was found that parents recognized and fed their own individual chicks. The young left the rookery independently of their parents when they had lost their down, about two months after hatching.

Unsuccessful breeders. If the eggs were lost, the nest was deserted; but it was usually re-occupied between the time when the chicks of other pairs were hatching and crèche formation. The second peak in the population curve (Fig. 1) during December is partly due to this return of unsuccessful breeders. Nests were rebuilt, the original pair-bond (at least in 'experienced' birds) was almost certainly maintained, and the usual behaviour patterns (including copulation) seen in the pre-egg stage were observed again, though on a reduced scale. No second clutch was laid, though there was a noticeable enlargement of the gonads. The male was more faithful to his nest territory than his mate and often came back earlier and remained longer, usually alone, at his pile of stones. These unsuccessful breeders have been mistaken by previous writers for 'parent guards' of the crèche, a function they do not perform.

'Inexperienced' or 'Unestablished' Breeders

These are probably three or four years old and breeding for the first, or perhaps the second, time. Their behaviour differs somewhat from that of the 'experienced' birds, though with some overlap due to individual variation. They often arrive back later and take up territories on the periphery of the colonies, or fill vacant places within them. They are the cause of most of the fighting. Courtship behaviour is more prolonged, egg and chick mortality higher, breeding efficiency lower. Thus Fig. 3 shows a badly built nest on a rock slab. The male is beside his mate, who has inadvertently scraped away the egg with her feet. Sheathbills (*Chionis alba*) are waiting near by. Such eggs fall an easy prey to these scavengers, which pay more attention to badly looked-after nests than to those of 'experienced' birds.

Non-breeding 'Wanderers'

These two- or three-year-old birds wander around the rookery in small parties and even visit rocky outcrops 1,000 ft. above sea-level far away from the breeding area. Some of them build poor nests or

Fig. 3. 'Inexperienced' breeders. Sheathbills (*Chionis alba*) waiting behind in hope of securing egg

occupy vacant sites for a short time before moving elsewhere or being turned out by older birds. A proportion of these 'wanderers', when dissected, showed undeveloped gonads despite their adult plumage. It is this age-group, together with some of the 'inexperienced' birds, that, under favourable conditions, will establish themselves in new ground and thus extend the range of the species.

Birds in Immature Plumage, or Yearlings

These are last season's young, easily recognized by their white throats. This immature plumage is carried for twelve months and moulted in February. They normally live among the pack-ice, but are occasionally seen at the rookery, where they associate with the 'wanderers'. Several were seen building nests in a half-hearted way on the periphery of a colony; but, like the 'wanderers', they never stayed in one place for long.

Individual Recognition

The problem of individual recognition is fundamental in interpreting the behaviour of breeding Adelies. Undoubtedly the two birds of a pair recognize each other from the time they are paired, before egg-laying, up to the time when the chicks go into the crèche. Previous literature summed up by Murphy[4] suggests that the pair-bond among adults is not maintained in subsequent seasons and that it is unlikely that the parents recognize their own offspring once the crèches have been formed. In their two papers on the Adelie, Sapin-Jaloustre and Bourlière[5,6] do not contradict this. Richdale[7] has, however, shown that the yellow-eyed penguins (*Megadyptes antipodes*) recognize each other as individuals.

In 1948–49 I placed coloured rings around the flippers of the chicks of marked parents before they went into the crèches and discovered that the parents found and fed their own offspring when in the crèche. Andrew and Roberts[8] have shown that adults return to the same nests and maintain the same pair-bond, and I believe this pair-bond is maintained, not merely because they return to the same nest-site, but because they recognize each other as individuals, even after a winter among the pack-ice.

Three important factors enter into this recognition: territory, visual and auditory recognition, and the so-called mutual display. Territory brings both members of a pair, and parents feeding chicks, back to known ground. A few chicks moulting their second down were marked and transferred to another crèche still within view of their own area but a quarter of a mile away. Most were back within twenty-four hours. But the actual nest-site is less important than visual recognition, since, though chicks may move out of a crèche and lie in their old nest-site when hungry, a parent is still able to recognize its chick should it be in a crèche several yards away.

Field experiments also showed that parents adopted chicks from other nests if small, but very rarely ones that were large enough to stand up. I believe that visual recognition is perhaps the most important single factor, being slowly acquired during the early stages of chick growth and fully developed by the time the chicks move into the crèche. Similarly with members of a breeding pair: the 'experienced' breeder may keep company with another bird, but be re-united to its true mate should the latter return to the nest later. Further, in at least three cases, a pair shifted their nest-site and yet remained together.

In the mutual display two birds stand facing each other and sway their necks from side to side with bills pointing upwards and flippers close to the side. The display may be 'loud' or 'quiet', when loud being accompanied by much noise with bills wide open, whereas in the quiet mutual display there is less neck movement and a soft 'squaw' with closed bill (Fig. 4) or no sound. The mutual display was seen most frequently before the eggs were laid, during nest-building; but was repeated each time one of a pair returned from the sea to take over incubation, or feeding duties, before the crèches were formed. The

Fig. 4. The 'quiet' mutual display between a pair of adults at their nest. The ice-axe by the nest is for scale

bird returning from the sea comes straight to its nest. Their usual behaviour and directness of purpose suggest they recognize their mates from a distance. The loud mutual display follows immediately they meet and is repeated several times, followed by the quiet display. There is usually a recrudescence of the loud display when the incubating bird walks off the eggs or chick and the new arrival takes its place.

A small chick at first pays little attention to this noise and movement, but soon begins to associate it with a fresh supply of food. As it grows bigger, its simple piping changes into a quivering call which has the same pattern as the sound made in the loud mutual display and is, as a large chick, accompanied by the same movements as seen between two adults (Fig. 5). The display and change of voice are well developed between parent and chick by the time the chick goes into the crèche and are repeated between parent and chick each time the parent returns with food. I therefore believe the most important function of the mutual display and call to be a confirmation of visual recognition. The parent probably recognizes its chick with greater certainty than the chick its parent. I have seen marked chicks pestering different parents for food; but have only once seen a marked parent feeding a marked chick not its own, and then for one brief and harassed mouthful, after which its own chicks, which were smaller, received the food.

Once it is established that adult pairs, and parents and chicks, recognize each other, it seems reasonable to suggest that this flightless bird, less than two feet in height, is helped in finding its way to its nest in the crowded rookery by recognizing its neighbouring adults.

The Ecstatic Display

The other most prominent display of the Adelie is the so-called 'ecstatic', originally described by Wilson[8] and Levick[9] and admirably re-described by Sapin-Jaloustre and Bourlière[6]. A subsidiary stage of this display appears to have been missed by previous writers.

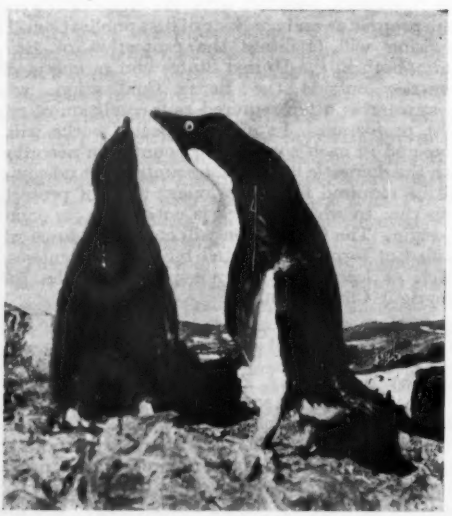

Fig. 5. The 'quiet' mutual display between a chick and parent on return of the parent from the sea with food

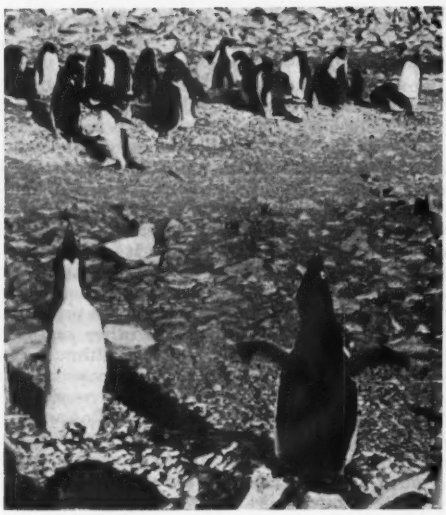

Fig. 6. Two Adelies in the ecstatic display alone in their nests

In the main display, with bill pointing upwards, the bird stretches to its full height and, beating its flippers backwards and forwards, emits a characteristic guttural throbbing sound (Fig. 6). The display is often contagious, but is not taken up by all the birds in a colony. It was seen most often early in the season and more among the unpaired 'inexperienced' and 'wanderer' males, particularly when attempting to establish themselves, than among the paired 'experienced' breeders. A sample of nearly a hundred dissected birds showed that the display was confined to the male up to the time when the chicks had, or should have, hatched, but thereafter was found in both sexes. I never saw two birds in one nest both in the ecstatic display. If the male displayed, the female by his side usually went through the same motions as seen in the quiet mutual display. A lone male standing in his nest would often by this display attract a 'wanderer' or 'inexperienced' or even an unsuccessful female to his side, and I consider its most important function to be in pair formation. When seen, less commonly, in lone marked birds incubating eggs or standing over chicks, it often appeared to be associated with stress.

In the subsidiary display, usually seen in lone birds before or immediately after the main display, or as a separate display, the bird rocks its head from side to side with bill directed either to the left or right axilla. The flippers continue to beat rhythmically backwards and forwards as in the main display. A soft "*gurr-gurr-gurr-gurr-gurr*" accompanies these movements which is characteristic of this particular display. Its function is, at present, obscure.

[1] Sladen, W. J. L., *Ibis*, **94**, 541 (1952).
[2] Andrew, J. D., and Roberts. J. M., *Ibis*, **94**, 540 (1952).
[3] Stonehouse, B., *Nature*, **169**, 760 (1952).
[4] Murphy, R. C., "Oceanic Birds of South America" (Amer. Mus. Nat. Hist., New York, 1936).
[5] Sapin-Jaloustre, J., and Bourlière, F., *Alauda*, **19**, 65 (1951).
[6] Sapin-Jaloustre, J., and Bourlière, F., *Alauda*, **20**, 39 (1952).
[7] Richdale, L. E., "Sexual Behaviour in Penguins" (University of Kansas Press, 1951).
[8] Wilson, E. A., Aves. British Nat. Antarctic Exped., 1901–4, Vol. 2, Zoology (1907).
[9] Levick, G. M., Natural History of the Adelie Penguin (British Antarctic (Terra Nova) Exped., 1910, Zoology, Vol. 1, No. 2, 1915).

NEWS and VIEWS

Prof. W. Pauli, For.Mem.R.S.

Prof. Wolfgang Pauli, who has just been elected a foreign member of the Royal Society, is best known for the exclusion principle, or 'Pauli principle', which he formulated in 1925, and which at once cleared up many unexplained features of atomic structure and atomic spectra. This principle, which states that no two electrons, or nucleons, can be in the same quantum state, is logically independent of the other laws of quantum mechanics. It applies to all elementary particles of half integral spin, and Pauli himself showed in a later investigation that a system in which such particles did not obey the principle, or in which it applied to photons or other particles of integral spin, could be described without logical contradictions, but would lead to physically unreasonable consequences. Besides the work on the exclusion principle, for which he was awarded the Nobel Prize for physics in 1945, Pauli has made many important contributions to theoretical physics, beginning with an article on the theory of relativity, which he wrote while he was a research student, simultaneously with his thesis on the quantum theory of the hydrogen molecule ion, and which has remained until now the standard text on the subject. He initiated the modern electron theory of metals by applying the exclusion principle, extended by Fermi to the statistic of many-particle systems, to the paramagnetism of metals. More lately he has contributed to the theory of mesons, and he has always been interested in a clear formulation of the basic concepts of quantum theory. His enthusiasm and insistence on fundamentals have inspired many collaborators and pupils, and by incisive criticism he teaches them to beware of loose thinking.

Technical Assistance to South and South-East Asia

The report for 1952 of the Council for Technical Co-operation in South and South-East Asia (pp. 16; London: H.M.S.O., 1953; 6*d*. net), which deals with the technical co-operation scheme of the Colombo Plan, indicates a marked increase in the flow of technical assistance over that for 1951; 90 experts and 538 training places were provided, as against 45 and 309, respectively, in 1951, but the limiting factor remains not the availability of funds, but the willingness of individual experts to accept appointments overseas. The increasing world-wide demand for technologists, and full employment in the supplying countries accentuate the problem, and improvement is due chiefly to improved administrative arrangements, to the maintenance of a sense of urgency in meeting the needs of under-developed countries and to the way in which the idea of the Colombo Plan has caught public imagination. Most of the experts provided during the year were engaged for specific projects where their duties included the training of local personnel as well as some measure of executive responsibility for the scheme, but the demand for experts whose main duties will be training local personnel is increasing. Schemes which combine capital and technical assistance have also increased. Ceylon, India and Pakistan have taken 118 of the 135 experts so far supplied and sent 689 of the 847 trainees. They have also supplied five of the experts and facilities for fifty-seven trainees. The United Kingdom has provided 67 experts and 279 training places in all, the corresponding figures for Australia being 40 and 286, for Canada 6 and 106, and for New Zealand 17 and 119. The demand for, and provision of, equipment for use by experts and for training and research institutions also increased; but although the sums involved are considerable, by December 31, 1951, only £400,000 out of the eight million pounds set aside for the Scheme had actually been committed, and in April 1952 it was agreed that the scheme should be co-terminous with the Colombo Plan and operate until June 30, 1957. The assistance provided has been mainly in the fields of medicine and health, agriculture and forestry, engineering, industry and trade, and transport and communications. In addition, the United Nations and the Specialist Agencies have provided the area with 502 experts and 564 trainees, and the corresponding numbers supplied by the United States are 210 and 403.

Universal Copyright Convention

The text of the Universal Copyright Convention which was signed at Geneva last September by the delegates of thirty-six countries, including the United States and the United Kingdom, has now been published by the United Nations Educational, Scientific and Cultural Organization (pp. 24; 125 francs, 2*s*. 6*d*. or 50 cents. Paris: Unesco; London: H.M.S.O., 1953). The Convention seeks to supplement existing copyright conventions, such as the Berne Convention, to which some forty countries (but not the United States or any Latin American countries, except Brazil) are parties. Ratification of the Convention by the United States and by Britain would greatly facilitate the obtaining of copyright protection in the United States for the work of British authors. At present, works in the English language can only secure protection in the United States if, in addition to registration at the Copyright Office in Washington, D.C., they are printed in the United States from type set up in that country. Under the Universal Convention, however, a country which requires compliance with formalities as a condition of obtaining copyright agrees to regard such conditions as satisfied, so far as works of foreign origin are concerned, if such works bear the symbol 'C' written in a circle, indicating that copyright protection is claimed, together with the name of the copyright proprietor and the year of first publication. This provision will facilitate the protection of British works, both in the United States and in many other countries outside the Berne Convention, where registration is often required as a condition of copyright protection. In other respects, works will be protected in each contracting country in accordance with the domestic law of that country, but no country will be required to give a longer term of protection than that to which a work is entitled in its country of origin. The Convention will come into force when ratified or formally accepted by twelve countries, of which at least four are not parties to the Berne Copyright Convention.

Planetary Influences on the Sun

A paper entitled "Planetary Influences on the Sun", by M. Kopecký, P. Mayer and V. Borovičková, of the Central Astronomical Institute, Ondřejov (*Bull. Cent. Astro. Inst. Czech.*, **3**, No. 3; 1952), contains the results of their work on sunspot activity and the positions of the planet Mercury. In a previous paper (**2**; 1950) certain results were given by the same authors on the planet Venus, and it was found that the period of variation of the relative number was approximately equal to the synodic rotation of

the sun with reference to the planet. Owing to the comparatively large eccentricity of the orbit of Mercury, perihelion and aphelion conjunctions are dealt with separately, and the material was reduced to those conjunctions for which the most outstanding effects would be expected: these are at inferior conjunction when both the earth and Mercury are in perihelion; and at superior conjunction when Mercury is close to perihelion and the earth to aphelion. Next, the results were analysed for the least favourable conditions, that is, when Mercury is in aphelion and the earth also in aphelion at inferior conjunction and when Mercury is in aphelion and the earth in perihelion at superior conjunction. The results are shown by a number of curves, but the correlation between the sunspot-characteristic and the synodic revolution of Mercury is not so well defined as in the case of Venus. It is suggested that this may be due to the large eccentricity of Mercury's orbit, which makes the statistical results more difficult, or to a smaller hypothetical influence of Mercury. Nevertheless, analogical forms of the curves of sunspot-characteristics for Mercury as for Venus have been obtained, and it is possible to assume that Mercury has an influence in the production of sunspots.

Rock Engravings in the Kilimanjaro Area

In the November and December numbers of *Man* there is an important article by H. A. Fosbrooke, sen., a sociologist of Tanganyika Territory, and Petro I. Marealle, chief of the Vungo division of the Chagga tribe, on the engraved rocks of Kilimanjaro and their meaning and use in initiation ceremonies. Rocks covered with apparently meaningless engraved lines are known from many parts of Africa. It is not suggested that the explanation given for the ones of Kilimanjaro applies in all cases; but it may well be that the others were used for some analogous purposes. In the November number, Fosbrooke describes the engraved rocks and supplies a couple of pages of excellent illustrations. In the December number, Marealle describes the use and explanation. "From the body of the youths of the age set are chosen 12 who are the children of people of importance. . . . The stone itself is engraved thus. The elder who is the instructor goes with the 12 youths to the stone. He wears a ring of hide, and says to them 'you see this stone and its engravings: look this is your whole country. The youths of old who made these marks were led by an elder who like myself knew much wisdom'. . . . Then the elder gives one of the 12 a little axe and shows him how to cut a line on the stone. The youth cuts a small mark from two to six inches long." Thus the rocks become more and more covered with engraved lines apparently meaningless. The ceremony, of course, continues, but enough has been quoted to give the gist of the explanation. This seems to be the first time such an account of such a ceremony and of the reason why these rocks get covered with engraved lines has ever been given; and it is factual, given by a man who formerly was an instructor, and is not an explanation produced out of the fancy of a psychological anthropologist.

High-frequency Electric and Magnetic Shielding

The third monograph of the series issued by the Research Institute of Applied Electricity, Hokkaido University, Sapporo, Japan, is entitled "Some Researches on High-Frequency Phenomena and Electrical Direct Heating" (Monograph Series No. 3; pp. 105; 1952) and contains four papers, two of which deal with the important problem of electrical shielding of high-frequency apparatus. In the first of these, Y. Asami, the director of the Institute and editor of the monograph series, and A. Matsumoto discuss in general terms the various sources and methods of suppression of electromagnetic leakage in high-frequency apparatus and then consider theoretically the principles of electric and magnetic shielding. They follow this by a description of a number of experiments performed with special care to detect the defects of apparatus made in Japan, and it is concluded that radio interference from high-frequency apparatus can be almost eliminated by application of the suggestions made. It is emphasized that, as some kinds of wire nettings used for screening are subject to rapid deterioration, good netting resistant to deterioration must be selected and used. The second paper, by T. Matsumoto, is a continuation of the one, on the theory of electromagnetic shielding by a shielding room of wire-netting, which appeared in No. 1 of the series. Several fresh problems are briefly considered: the effects of finite dimensions of the current-loop wave source, and of the eccentricity of its position relative to the centre of the shielding room; and the theories of double shielding formed by two concentric spherical walls of wire-netting, and of shielding by a shielding room consisting of a cylindrical cavity with perfectly conducting walls and with a wire-netting bottom.

Seasonal Variation in the Reproductive System of Garter Snakes

Although many papers have been written, there is still much that is not understood concerning the external and internal factors responsible for the cyclic nature of reproduction in reptiles. Investigations of the seasonal fluctuations in various parts of the reproductive system of several species of lizards, snakes and turtles have revealed interesting species differences. For a more complete understanding of reptilian reproduction it would appear that detailed descriptions of the seasonal changes of many species are desirable (*J. Morph.*, 90, No. 3; May 1952). Such a study was carried out by Wade Fox on the common garter snake (*Thamnophis*), several species and subspecies of which could easily be obtained throughout the year in the vicinity of San Francisco Bay. These investigations showed that the gonads of the male garter snake, *Thamnophis elegans terrestris*, exhibit marked seasonal variation. The testes begin to increase in size in the early spring, reach their maximum size and weight in late July, decline in the autumn, and are of minimum size during the winter months. These macroscopic fluctuations are accompanied by corresponding histological changes.

Collections of British Birds and Eggs

In the March number of the *Museums Journal* Mr. Colin Matheson (National Museum of Wales) has performed a useful service in that he has collated much information regarding the present location of museum collections of British birds and eggs. In order to add to the value of such notes, he has included collections which are known to have been destroyed during the Second World War. Changes in outlook, as well as in economic and social conditions, make it unlikely that many more large collections will be formed, and hence it is important that ornithologists should know the whereabouts of the material available for study.

Technical and Technological Education in Britain

In his presidential address to the Association of Teachers in Technical Institutions, delivered at Leeds on May 24, Mr. C. L. Bott, principal of Southport Technical College, referred to the lack of progress in secondary technical education in Britain, and to the need for careful thought as to what exactly the secondary technical schools are intended to do. Mr. Bott visualizes them as catering for three groups of students: a few who would proceed to a university or college of technology; those of a less academic type who require the stimulus of a more practical type of training; and those who would ultimately be trained as technicians. He emphasized the necessity for effective and continuous education from the secondary technical schools whether to a university or to a technical college, but he made the surprising remark, in view of what has been said, for example, at recent conferences of the Federation of British Industries, that firms now find difficulty in training workers themselves and look more and more to the technical colleges. He also commended the provision of sandwich courses: both education and industry are convinced, he said, that such schemes could ensure a sound integration and correlation of works and college training, and he thought that the scope and number of such schemes could be extended with advantages both to students and the community as a whole. In his reference to higher technological education, Mr. Bott was less happy, pursuing the chimera of a national award, which the Government has wisely rejected; he passed over the vital questions of adequate resources and conditions which will attract staff of high calibre, both of which are essential to enable the technical colleges to contribute significantly to the supply of technologists. Nor did he distinguish clearly between technician and technologist, or discuss the importance of an appropriate numerical balance between the two.

National Research Council of Canada: New Members

Three new members have been appointed as follows to the National Research Council of Canada for a three-year term ending on March 31, 1956: Dr. R. F. Farquharson, Sir John and Lady Eaton professor of medicine and head of the Department of Medicine, University of Toronto; Dr. E. G. D. Murray, professor and chairman of the Department of Bacteriology and Immunology, Faculty of Medicine, McGill University; Dr. David L. Thomson, dean of the Faculty of Graduate Studies and Research and chairman of the Department of Biochemistry, McGill University. In addition, the following three members, who have already served one term on the Council, have been reappointed for another three years: Dr. C. W. Argue, dean of science and professor of biology, University of New Brunswick; Dr. A. G. McCalla, dean of agriculture, University of Alberta; Dr. G. M. Shrum, professor and head of the Department of Physics, University of British Columbia. The National Research Council consists of a president, two vice-presidents and seventeen members. The members serve in an honorary capacity for a three-year term which may be renewed once; they are appointed by Order-in-Council and are chosen to represent the universities and industry, the selection being made in such a way as also to provide adequate geographical representation.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: N. R. Fuggles-Couchman (agricultural officer, Tanganyika), regional assistant director of agriculture, Tanganyika; W. B. Mason (senior agricultural officer, Gold Coast), assistant director of agriculture, Gold Coast; W. V. Rose (agricultural officer, Nyasaland), deputy director of agriculture, Barbados; F. E. Hughes (conservator of forests, Gold Coast), deputy chief conservator of forests, Gold Coast; H. S. H. Watson (senior assistant conservator of forests, Northern Rhodesia), deputy conservator of forests, Northern Rhodesia; A. T. Crow (geologist, Gold Coast), senior geologist, Gold Coast; F. H. Fitch (senior geologist, North Borneo), deputy director of geological surveys, North Borneo; E. G. Davy (assistant director of observatory, Mauritius), director of observatory, Mauritius; E. G. B. Jones (agricultural instructor, British Guiana), agricultural officer, Jamaica; Miss C. McGlade (clerk, grade I, Statistical Department, East Africa), statistician, Statistical Department, East Africa; J. C. Williams (engineering surveyor, Water Development Department, Tanganyika), topographer, Department of Geological Survey, Uganda; S. J. A. Williams, agricultural officer, British Honduras; J. Armour, veterinary officer, Nigeria; N. St. G. Hyslop, veterinary research officer, Kenya; W. P. Unsworth, veterinary officer, Department of Agriculture, Trinidad; C. S. Eastman, assistant conservator of forests, Nigeria; M. Garstang, assistant meteorologist, British Caribbean Meteorological Service, Trinidad; V. E. Sills, biochemist, Agricultural Department, Fiji.

Physical Society: Officers

At the annual general meeting of the Physical Society held on May 15 the following officers were elected: *President*, Prof. R. Whiddington; *Honorary Secretaries*, Mr. C. G. Wynne and Dr. H. H. Hopkins; *Honorary Treasurer*, Mr. A. J. Philpot; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Librarian*, Dr. R. W. B. Pearse; *New Members of Council*, Prof. P. M. S. Blackett, Prof. N. Feather and D. W. Fry.

Fourteenth International Congress of Zoology

The Fourteenth International Congress of Zoology will take place in Copenhagen during August 5–12, and more than five hundred zoologists from forty-four countries outside Denmark have already indicated that they will be present. The president of the Congress will be Dr. R. Spärck, professor of zoology, University, Copenhagen, and the secretary-general, Dr. Anton Fr. Bruun, Zoological Museum of the University, Copenhagen. Those who wish to become members of the Congress are invited to apply to the Secretariat, Krystalgade 27, Copenhagen K, Denmark. The membership fee is 100 Danish kroner (about £5). Associate membership costs 50 Danish kroner, but does not entitle the member to receive the proceedings of the Congress. Accommodation may be arranged through any travel agency, and the secretariat is also prepared to arrange hotel accommodation for members but applications should be made as early as possible. A preliminary list of twenty sections of zoology has been suggested, so that it will be possible for members to meet their colleagues in fairly restricted fields, but more sections may be established depending upon the

communications offered by members. Zoologists wishing to be present at this Congress should make application through their bankers on Form *T*.2 for special allotment of exchange for the purpose of attending the Fourteenth International Congress of Zoology.

The Night Sky in June

New moon occurs on June 11d. 14h. 55m., U.T., and full moon on June 27d. 03h. 29m. The following conjunctions with the moon take place: June 8d. 08h., Venus 8° S.; June 13d. 07h., Mercury 0·1° N.; June 21d. 16h., Saturn 8° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Mars on June 2d. 10h., Mercury being 1·0° N. Mercury is an evening star, setting at 21h., 21h. 55m. and 21h. 35m. on June 1, 15 and 30, respectively. Venus, a morning star, rises at 2h. 20m., 1h. 55m. and 1h. 30m. at the beginning, middle and end of the month, respectively; the stellar magnitude of the planet averages − 0·4, and the visible portion of the illuminated disk varies from 0·36 to 0·54. Mars is an evening star, setting at 21h. at the beginning of the month, but, as it is gradually drawing closer to the sun, it is badly placed for observation during June. Jupiter, a morning star, rises about the same time as the sun on June 1, and at 3h. and 2h. 10m. on June 15 and 30, respectively, but will not be favourably placed for observation until later than the middle of the month, when it can be seen in the constellation of Taurus. Saturn is visible until the morning hours, its times of setting on June 1, 15 and 30 being 2h. 10m., 1h. 20m. and 0h. 20m., respectively, and it can be seen a little north of Spica during this time. No occultations of stars brighter than magnitude 6 take place in June. Summer solstice occurs on June 21d. 17h.

Announcements

Prof. Irene Manton, professor of botany in the University of Leeds, has been elected an honorary member of the Danish Academy of Sciences and Letters.

Sir Eric Rideal, professor of chemistry in King's College, University of London, has been appointed chairman of the Advisory Council on Scientific Research and Technical Development of the Ministry of Supply in succession to Sir John Lennard-Jones.

Mr. J. T. Saunders, secretary-general of the Faculties in the University of Cambridge, and formerly lecturer in zoology in the University, has been appointed principal of University College, Ibadan, in succession to Dr. Kenneth Mellanby.

The Council of the Royal Society has appointed Mr. A. S. Laughton, of King's College, Cambridge, to be John Murray travelling student in oceanography and limnology. Mr. Laughton will carry out research on the physical properties of sediments, part of the work being carried out at the Lamont Geological Observatory, Columbia University, New York, during 1954.

The following changes in the University of Sheffield have recently been announced. *Appointment:* Dr. A. F. Ruston, senior lecturer in pure mathematics. *Resignations:* D. K. Roberts, lecturer in mechanical engineering and sub-warden of Ranmoor House; R. M. Haythornthwaite, lecturer in civil engineering; Dr. K. Burton, lecturer in biochemistry; and F. Newby, information officer and librarian to the Department of Glass Technology.

The Oliver Memorial Fund is offering an award worth £50 to a British subject for original work or services in connexion with research, organization or the donor aspect of blood transfusion. Applications or information directing attention to suitable candidates must be submitted before August 31 to the honorary treasurer of the Fund, F. W. Mills, c/o National Provincial Bank, Ltd., Holborn Circus, London, E.C.1.

A continuation of the seminar on polymer science (cf. *Nature*, **171**, 65; 1953) will take place on June 29; a programme and abstracts of lectures can be obtained from the Chemistry Department, University College, London, W.C.1.

The Royal Microscopical Society will hold a conversazione in its rooms at Tavistock House South (Entrance *D*), Tavistock Square, London, W.C.1, during June 9–10 (7.30–10 p.m.) in honour of the Coronation of H.M. the Queen, Royal Patron of the Society. The conversazione will comprise demonstrations illustrating the development of the microscope and the advances in microscopical technique made from the time of the granting of the Royal Charter by Queen Victoria to the present day. The exhibition will be open to the public during June 11–12.

The Institute of Physics has awarded Bowen Prizes of fifteen guineas each to the following for their papers published in the *Journal* of the Institute: G. T. Wright, University of Birmingham (a single-channel pulse-height discriminator of high speed and stability); G. D. Dew, National Physical Laboratory, Teddington (preservation of groove form in replicas of diffraction gratings); H. Aspden, Trinity College, Cambridge (measuring the magnetic permeability of rod specimens). These Prizes are provided by the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., from a fund established by the late Mr. William Bowen, and are awarded to persons not more than thirty-five years of age whose papers are judged to be the best in respect of originality, scientific value, practical utility to instrument makers and users, and presentation.

On the recommendation of a joint committee of the Institution of Mining and Metallurgy and the Institute of Metals, Capper Pass awards have been made as follows for papers, the subjects of which are shown in brackets, published during 1952 in either the *Transactions of the Institution of Mining and Metallurgy* or the *Journal of the Institute of Metals*: E. Davis and S. G. Temple, jointly (batch and continuous annealing of copper and copper alloys), C. P. Paton (batch thermal treatment of light alloys), Dr. E. C. Ellwood and T. A. Henderson, jointly (formation and control of magnetite during copper smelting operations), P. M. J. Gray (production of pure cerium metal by electrolytic and thermal reduction processes) and E. A. Hontoir (determination of sulphur in iron pyrites). The awards are each for £50, except the last-named, which is worth £25. They are made annually from a sum of £200 given each year by the firm of Capper Pass and Son, Ltd., Bristol, and are intended to encourage the publication of papers on processes and plant used in extraction metallurgy, assaying and on processes and plant used in all branches of the non-ferrous metal industry.

BIRKBECK COLLEGE, LONDON

NEW BUILDING

AT three o'clock in the morning in the "Crown and Anchor" public house in the year 1823, Dr. Birkbeck was elected president of the London Mechanics' Institution, then and there founded. That institution has grown and thriven for more than a hundred years and still serves the student who has to pursue learning and earn his living at the same time. The adoption of the name "Birkbeck College" in 1907 symbolized the growing claim to university status, and the admission of the College as a School of the University of London in 1920 marked the accomplishment of ambitions which long existed among its teachers and students. In 1930 the Court of the University set aside part of the University site in Bloomsbury for a new building for the College, the premises in Fetter Lane of which, though referred to at their opening in 1885 as "spacious and convenient", had become quite inadequate.

In spite of generous benefactions from many sources, sufficient money was not accumulated until 1939 when the new building was started. However, operations had to be abandoned in 1940 with only the steel skeleton erected. Work was resumed after the War, and the hopes and labours of so many years culminated on April 28 when H.M. Queen Elizabeth the Queen Mother, patron of the College, visited the new building. In the presence of a distinguished gathering in the Senate House of the University, Her Majesty was welcomed to the College by the Master, Dr. J. F. Lockwood. The president of the College, the Right Hon. Lord Justice Denning, then invited the Queen Mother to declare the new building open. In her address, Her Majesty referred to the "absorbing story" of the College's development and to those whose enterprise turned what might have been a story of disaster into a record of triumph. "To you," she concluded, addressing the students, "we confidently look for the preservation and enrichment of our civilization."

Having unveiled a commemorative inscription in the entrance hall, Her Majesty inspected part of the new building. She was received in the Psychology Department on the fourth floor by Prof. C. A. Mace and Mr. A. Rodger. During the inspection of the Psychological Laboratory, Her Majesty was shown experimental studies on perception, learning, fatigue and other topics representative of the normal work of a psychological department. Among research activities in applied psychology displayed in the laboratory were an investigation into new methods of plotting the movements of aircraft, and the training of a blind worker by a blind instructor in skilled assembly work. A case study in vocational guidance was also in progress during the visit.

On the third floor, occupied by the Chemistry Department, Her Majesty was received by Prof. W. Wardlaw, Dr. D. J. G. Ives and Dr. D. H. R. Barton. She passed through the main teaching laboratory, with accommodation for ninety students, where she watched a practical class in progress, and spoke to some of the students.

The Queen Mother then inspected the library, which includes a particularly large and attractive reading room. Before leaving, Her Majesty took tea in the Council Chamber.

In addition to the Departments already mentioned, the new building houses the Departments of Physics (Prof. J. D. Bernal), Zoology (Prof. W. S. Bullough), Geology (Dr. A. T. J. Dollar), Botany (Prof. C. T. Ingold), Geography (Prof. W. G. East), and Mathematics (Prof. A. C. Offord).

The Faculty of Arts has accommodation for its staff in Malet Street; but most of its teaching is done in space kindly provided by neighbouring institutions.

Of the 214 degrees awarded to Birkbeck students during the session ending July 1952, forty were postgraduate. The facilities which are now available for research will make possible a wide extension of opportunities for students who wish to prepare for the higher degrees of the University of London.

HUMAN PERFORMANCE

THE third symposium of the Ergonomics Research Society was held in the Department of Human Anatomy, University of Oxford, during April 13–16, the subject being "Human Performance, its Measurement and Limitations". The diversity of disciplines related to the study of the relation between man and the environment in which he works was well illustrated by the number of scientific departments represented; among the hundred and thirty members and visitors who attended were leading workers from many parts of the world, including, in particular, Scandinavia, Finland, Germany, the Netherlands and the United States. The deliberations fell into two main categories: those with a predominantly physiological approach to the efficiency of performance in hard manual work, and those of a psychological nature dealing with some of the lighter industrial work processes. The discussions revealed a clear realization of the complementary roles of these different methods of assessing human performance and the necessity of relating them realistically to the problems actually confronting the production engineer. They also indicated the gap that exists between fundamental work and the application of relevant results to industrial work.

In his opening address, the chairman, Prof. W. E. Le Gros Clark (Oxford), directed attention to the interplay of fundamental and *ad hoc* research on which successful ergonomic investigation depends. As long as the ergonomic research worker, stimulated by some practical problem, has the freedom to develop his interest in the more fundamental aspects, the subject can be regarded as a suitable one for university departments. Of the various difficulties attending such research, he stressed in particular the inadequacy of the present supply of human subjects for laboratory tests.

Sir Charles Lovatt Evans (consultant physiologist, Ministry of Supply), in an introductory address, dealt with the contributions which human physiology can make to the improvement of work and working conditions. Human physiology has reached a stage in its development where, generally speaking, it possesses the necessary basis of method and theory for the

study of almost any physiological process which might be of interest in human activity—in industry, sport or war. He illustrated this by an account of the history of muscle physiology and showed how our present understanding of the anatomical, dynamic and energy characteristics of muscle action has been attained and can be employed in ergonomics. Dr. O. H. Wansborough Jones (chief scientist, Ministry of Supply) discussed ergonomics from the point of view of the user and posed a number of general questions for the consideration of the symposium. A distinction should be drawn between the 'all-out' character of war-time ergonomic and operational research and that of peace time, where the objective should be increased productivity without increased strain. Looking to the future, one should bear in mind the change that will come about with the virtual elimination of the human operator; it means that ergonomics will have to re-orientate itself increasingly to the problems of maintenance and transport. At the present time, said Dr. Jones, these are rather neglected. It is also not sufficiently appreciated that the duties of the administrator and executive officer present ergonomic problems, for this type of work is often done at very high pressure and inordinately long hours, particularly so in the higher posts in business and the Civil Service.

A number of the papers dealt with the physiological methods of work-study in the laboratory and the factory. Techniques for the continuous registration during exercise (on a bicycle ergometer with electrical braking-system) of ventilation-rate, oxygen consumption, carbon dioxide production and pulse-rate were described by Dr. F. H. Bonjer (Leyden). For the gas analyses he uses a Kipp diaferometer employing the Noyons principle whereby the composition of the gas mixture can be measured by changes in the electrical resistance of a heated wire. The cardiotachometer depends on photo-electric recording of fluctuations in the light transmission through the ear-lobe. The usefulness of estimations of heart-rate and metabolic cost in work study cannot be overemphasized, and hence there is a great need of methods which can be used at the work bench. Special attention was devoted in a number of papers to the portable instruments devised at the Dortmund Max Planck Institute for these purposes, the Kofranyi–Michaelis respirometer and the Müller photo-electric pulsometer. The *K–M* respirometer was used in laboratory investigations described by Passmore at Glasgow to determine individual variation in metabolic cost of standardized stepping and walking. The reliability of this last-named instrument, even in the very difficult environmental circumstances of underground work, was proved by J. G. Durnin, R. C. Garry and R. Passmore in an investigation of the metabolic cost of a variety of coal-mining activities. The information obtained gave a picture of the daily pattern of work of underground miners, and comparisons could be made with findings in the Ruhr and other coal-fields. Dr. O. G. Edholm (London) showed how by keeping a detailed diary of the complete 24-hourly routine (as carried out on a group of military cadets), it was possible to obtain a reasonably accurate evaluation of the energy requirements of the group. In this investigation it was only necessary to make Douglas bag metabolic determinations for a few tasks and, by using figures obtained by other workers, the estimate (3,420 kcal.) was found to agree quite well with the calorie intake (3,700 kcal.) as determined by a dietary survey carried out simultaneously by Prof. R. A. McCance and Miss E. M. Widdowson.

The close relationship between the intensity of the work measured by the metabolic cost and the heart-rate during work indicates the value of the pulse-rate as an index of effort. This relationship was demonstrated by Miss I. Ryhming (Stockholm) in a cycling and a step test modified from the well-known Harvard pack test. The new test gave similar results to the bicycling test and was easier to use in the factory. In an outstanding paper Prof. E. A. Müller (Dortmund) discussed the factors governing the pulse-rate/metabolic relationship, in particular the type and efficiency of the work, the cross-section of the muscles used and the extent of the static effort demanded by the work. For many patterns of work there existed a level of activity which could be sustained for hours. The energy expenditure at this optimal condition varied with the factors mentioned; but the pulse-rate difference between work and rest did not exceed about 35 beats/min.

How these findings can be applied to the analysis of the complete daily shift of industrial work was elucidated by Prof. G. Lehmann (Dortmund) and Prof. E. H. Christensen (Stockholm). Prof. Lehmann has used physiological measurements to obtain a more rational spacing of rest pauses in heavy industry and to eliminate the extra stresses imposed by unsuitable posture, static effort and adverse environmental temperatures. As a yardstick one can take an energy expenditure of 4 kcal./min. as the normal average output of a heavy worker. With a higher output per minute, rest pauses will usually be required to reduce the average output to 4 kcal./min. It is necessary to take full account not only of permitted rest periods but also of the arbitrary and enforced pauses which appear in all types of work and to rearrange these as recognized pauses so as to prevent the onset of fatigue. The pulse-rate determinations can be used extremely effectively in doing this, and the portable pulsometer and respirometer has made such investigations possible at the work place. Prof. Christensen's approach was complementary to that of the Dortmund workers, and he reported on ninety-odd different jobs studied in a steel factory. The heart-rate expected from the oxygen usage in these different tasks was compared with that actually observed, and, where this was excessively high, the cause was sought in the arrangement of the work, the methods used and the design of machinery, or often in the high temperatures prevailing. Changes could then be made and the degree of improvement evaluated. The performance of work, representing probably the limit of sustained human output, was the subject of a paper by Dr. M. J. Karvonin (Helsinki). He described the activities of lumberjacks taking part in the four-day national forest competition of Finland, a task which required an average daily consumption of 5,460 kcal., of which 40 per cent was derived from fat and 12 per cent from protein. The ability to work at this rate depended partly on the possession by lumberjacks of a physique quite different from that of the average Finn, but also on the incentive of the competition.

Apart from the more classical methods of determining the physiological cost of work, Dr. A. Lundervold (Oslo) indicated the value of electromyography. He described the results of his studies on typewriting in which he determined the muscles participating and the sequence of their activity. He also showed how the degree of their activity was

increased by various forms of stress such as increased rate of work, fatigue and poor environmental conditions. The possible relationship between the increased static activity imposed by these stresses and myalgia was indicated. Dr. H. Seyffarth (Stockholm) emphasized the importance of ordinary clinical examination in studies such as these; examinations which can afford considerable insight into the conditions of the muscles. Dr. Gerda Seidelin (Copenhagen) also represented the clinical approach and stressed the limitation of activity that can be caused by poor body mechanics inducing pain. The pain may be relieved by the conventional physiotherapeutic methods; but permanent results are only achieved by correcting the posture, and this can be done only by studying the patient at the work which has produced the condition.

Of the contributions of the applied psychologists, the main emphasis was on the possible application of information theory to the measurement of man's overall performance in complex tasks. The place of the theory in the quantitative prediction of man's responses to known stimuli and *vice versa* was discussed by Dr. W. E. Hick (Cambridge). He stressed, however, that the position of the theory in this sphere is not clear and that, if established, will not replace more specific methods of investigation. Dr. W. D. Garvey (Washington, D.C.) described experiments in which he obtained a measure of the time necessary for a subject to code information by arranging that the display and response were constant. The results support earlier conclusions that the appropriate coding of information which the subject receives is an important factor in determining how much of it will be usefully dealt with. A different approach to the study of the application of information theory was reported by Mr. E. R. Crossman (Cambridge), who, by the use of a simple card-sorting task, showed that the overall time taken is mainly a function of the amount of choice made.

Illustrating the more specific criteria used in the study of man's performance were the papers of Dr. A. Leonard (Cambridge) and Dr. Shirley Spragg (Rochester, New York), both of which were concerned with display-control tasks. Dr. Leonard reported on experiments to determine the value of advanced information in such tasks, and Dr. Spragg on the effects of different relationships between the movement of the control and that of the display on tracking performance.

Work study was the subject for discussion at the concluding session. The importance of the practice was stressed because of the part it can play in increasing productivity and in coping with the ageing population; but it was pointed out by Mr. C. R. Wynne-Roberts (London) that, although it is an essential technique, it is only one of those available in industry for increasing individual efficiency. The present stage in the development of work study was outlined by Dr. D. Seymour (Birmingham), who considered that the advances being made are due to the application of pre-existing information rather than to an increase in fundamental data. The latter, though, is essential for the proper development of work study, and some improvement can be achieved by the dovetailing of the work of the psycho-physiologist and the engineer. A rather similar suggestion was put forward by Mr. R. Conrad (Cambridge), who stressed the need for bridging the gap between laboratory investigations and *ad hoc* studies in the factory. In his opinion, this can be done only by a willingness on the part of the psychologist to take the experimental methods at his disposal on to the shop floor and for the work-study engineer to present appropriate problems for laboratory investigation. Finally, Mr. L. G. Humble (London) gave a picture of the practical problems experienced in applying the results of work study, due to the resistance that is encountered both from the management and from the worker.

INDUSTRY AND THE UNIVERSITIES IN BRITAIN

CONFERENCE IN NOTTINGHAM

THE report of the conference on industry and the universities, organized by the Federation of British Industries North Midland Regional Council and the University of Nottingham, and held at Nottingham on September 24, 1952, has now been published*. It was the sixth regional conference of its kind to be held since the national conference on this subject held in November 1949, and the report includes the text of the following addresses: by Lord Hives on what industry requires from the universities; by Prof. J. A. Pope on whether universities can contribute to the needs of industry; by Sir Edward Herbert on what is the best training for the university student who wants to find a career in industry; and by Dr. F. A. Wells on the study of industrial organization and management as an academic discipline, and the contribution which industry itself can make in this field.

Lord Hives, who began by describing the methods used by Rolls Royce, Ltd., in dealing with an annual intake of about thirty university graduates, emphasized that his firm does not expect the universities to supply ready-made technicians, designers, metallurgists or chemists. It expects the universities to turn out men who are capable of thinking and who have received the basic training in the fundamental sciences essential to their future work; whose brains have been trained to tackle problems; and who, of their own initiative, can follow a problem through, step by step and logically, taking advantage of previous experience on allied work. Furthermore, said Lord Hives, his firm liked good citizens—men who can express themselves well and hold their own in the conference, and can report clearly and concisely on their work. Lord Hives does not believe that the universities can deal with specialized technological education satisfactorily; he is of the opinion that they are too remote from the rapidly changing requirements of industry, and they cannot afford the extensive and complicated equipment used in modern industrial engineering investigations.

For these reasons he said that he is doubtful as to the value of the proposal to establish an institute of technology and inclines to prefer graduates who come direct from their three years at a university to those who come from the Massachusetts Institute of Technology or one of the Continental technological institutes. The engineering industry, is, however, disturbed at the inadequate numbers of men coming from the universities, and Lord Hives suggested that the balance between arts students and those studying science and engineering is out of keeping with the

* Report of the Conference on Industry and the Universities, organised by the F.B.I. North Midland Regional Council and the University of Nottingham and held at the University, 24 September 1952. Pp. vii+39. (London: Federation of British Industries, 1953.) 4*s.* 6*d.*

demand. He stressed the importance of the appointments officers of the universities and suggested that they deserve better support. As regards quality, more first-class graduates are required and, particularly in the average man, an improvement in quality is desirable.

Sir Edward Herbert's address in some respects overlapped that of Lord Hives. He too agreed that industry recognizes that the first function of a university must always be that single-minded pursuit of learning and continual advance of knowledge which are essential to the existence and growth of a civilized society. The value of a university graduate in industry, or in any other walk of life, lies in the trained and flexible mind which the three or four years of mental discipline may be expected to produce. It does not lie in the possession of any particular body of knowledge, and Sir Edward suggested, in considering what qualities industry looks for in its recruits from the universities, that we should look not at the graduate starting his first job, but at the man he hopes to become at thirty-five or forty on the threshold of major responsibilities. His future would then turn, not on his specialized knowledge but on his capacity to assume responsibility.

Accordingly, Sir Edward thought, industry would seek for such future leaders a combination of three main categories of ability. First, the ability to equip oneself thoroughly with expert knowledge of the particular aspect of the business in which one is engaged; this provides the basis of genuine authority. Second is the ability to relate this specialist function to the conduct of the business as a whole, including not merely the problems of the industry but also of the community which that industry serves. The third is the ability to sustain the moral burden of responsibility. Sir Edward made no suggestion as to what formal part the university can hope to take in preparing a man for this last responsibility; but a university should, he thought, be able to foster a lasting regard for other human beings, and it should strive to instil the conception of duty and service. All who hold authority in a community should be constantly aware of the human implications of the decisions they have to make from day to day, but Sir Edward believed that professional training in business administration and management should come some time after the degree course, and not form part of it. Finally, he stressed the immense value of a friendly understanding between the universities and industry and the need for industry to become much more imaginatively alive to its own opportunities and achievements.

The importance of co-operation between the universities and industry was also stressed by Prof. Pope, who pointed out that, with the adequate financial assistance now available, practically all able boys and girls from the grammar and secondary schools in Britain are proceeding to a university; as a consequence, the direct entry into industry from schools has suffered considerably, and this is a problem which has been considered more particularly at a subsequent conference of the Federation of British Industries held last October. Apart from the professional qualifications, Prof. Pope maintained that a university education should discipline a person to be intellectually honest and to be capable of a balanced view of issues as they arrive.

While Dr. Wells also stressed the need for more and closer personal relations between industry and the universities, particularly on the social science side, his address was largely a plea for specific assistance from industry in providing material for economic studies. First, he said, more opportunities are needed for studying the organization of firms and for investigating their problems at first hand. Secondly, there is the desirability of having access to business records, particularly old historical records; and thirdly, the assistance of industry in developing the method of teaching based on case study. Fourthly, it is desirable to know more about the associations of the business world, such as the Federation of British Industries, the British Employers' Confederation and some of the more important sectional organizations. Far more, he said, is known of the trades union movement than of its counterpart on the employers' side.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FIFTIETH ANNIVERSARY

WHEN the South African Association for the Advancement of Science met last year, during July 7–12, in the buildings of the University of Cape Town, it was to celebrate the golden jubilee of its foundation, for, though the date did not exactly coincide with fifty years, the occasion was fitting in that it was in Cape Town on September 12, 1901, when the constitution of the Association was drawn up, and on April 27, 1903, also in Cape Town, when the first annual meeting was held. The meeting last year, which was under the presidency of Dr. B. F. J. Schonland, of the Bernard Price Institute of Geophysical Research, Johannesburg, was marked by the invitation of the following distinguished guests from overseas: Sir Lawrence Bragg (Cambridge) and Sir Edward Salisbury (Kew Gardens); Prof. L. E. J. Brouwer (Amsterdam) and Prof. J. H. Oort (Leyden); Canon G. Lemaitre (Louvain) and Prof. G. Magnel (Ghent); Dr. H. Vallois (Paris); and Prof. A. da Silva Rego (Lisbon). The official representatives of other bodies were as follows: for the sister Associations in Australia and New Zealand and in the United States, Sir Kerr Grant, the Australian physicist, and Dr. J. D. J. Hofmeyr, of Pretoria, respectively; for the Royal Society of South Africa, the oldest scientific society in the country (which, incidentally, was celebrating its seventy-fifth anniversary), Prof. R. W. James, of the University of Cape Town; and for the Suid-Afrikaanse Akademie vir Wetenskap, Dr. T. E. W. Schumann, director of the Weather Bureau of the Union of South Africa.

The activities of the meeting are recorded in the October–November issue of the Association's journal, the *South African Journal of Science*, and in this issue are published a brief description of the meeting, Dr. Schonland's presidential address and the texts of eleven papers, included in which are those of overseas visitors—namely, Dr. Vallois, Canon Lemaître, Prof. Oort, Prof. Rego, Sir Lawrence Bragg, Sir Edward Salisbury and Prof. Brouwer.

Dr. Schonland began his address by outlining the inception of the Association under the presidency of Sir David Gill, then H.M. Astronomer at the Cape, and showed how the early enthusiasm of the first meeting, at which 703 full members and 36 associates attended, led to a membership of 1,322 in 1906,

which has never been since surpassed. Dr. Schonland expressed disappointment that the membership in recent years has been but a little more than a thousand, for South Africa has expanded enormously since 1906 and with this expansion the need for, and potential value of, such a body as the Association. The general aims of the Association have not changed at all with the passing of years: "We exist," he said, "primarily to create and foster a scientific fraternity in South Africa, not to publish original work. We exist to provide a common meeting-ground for South African scientists and a forum for general discussion of the problems of this country from the scientific angle." He defended the use of Afrikaans by those who preferred it, for "we were intended by our founders to be parochial, and we should pride ourselves on being parochial. I would suggest that if we try to be anything else we will have mistaken our real aim".

Having thus firmly and, most people would agree, wisely placed the Association in its proper perspective, Dr. Schonland went on to make some concrete suggestions. The *South African Journal of Science* should have a series of semi-popular articles reviewing and surveying the new ideas of science and so bridge the gap between those who teach and do advanced research work and those who pay for it. This, he thought, is the proper function of the *Journal*, and it is but one aspect of the Association's duty, as representative of all sections of scientific opinion in South Africa, "to take a stronger, a more continuing and a more active interest in all scientific developments, national and university, in South Africa and to study carefully what is being done in other countries".

Besides his plea that the Association needs to form a standing committee to watch over scientific education in schools, Dr. Schonland suggested that the Association might consider taking a part in the formation of a body on the lines of the British Parliamentary and Scientific Committee and also help in the creation of better facilities for advanced research in South Africa. On this last-named point, he cited the instances of the National University in Canberra and the Institute for Advanced Studies in Dublin, but he made the interesting suggestion that a more acceptable solution might be the creation of a number of specialized institutes for advanced study, attached to and forming part of those universities which for one reason or another are best suited for them.

BASIS OF TECHNICAL EDUCATION

GENERAL education to-day should be planned so as to enable the ordinary citizen to adapt himself to the needs of technological society and to understand what is happening and what is required of him. This was the theme of an international conference convened by the United Nations Educational, Cultural and Scientific Organization at Unesco House in June 1950*.

Broadly, the Conference found that organized social foresight is essential to enable the educational system of a country to prepare children for the type of life and work they are likely to encounter, and that a substantial development of technical education is required at all levels: at present it is wholly inadequate for future needs, while the practical content of general education is also inadequate for the needs of future citizens of a technological society. The cultural content of technical education is also generally inadequate; technical education requires special consideration, and training for adaptability is an outstanding requirement in an age of ultra-rapid technological change. The education of women and girls also demands particular attention in view of their dual role as workers and home-makers, and improved administrative arrangements are essential if education is to fulfil its true function in such a society.

The report does not suggest that all these propositions apply equally to every country, though the Conference considered that, so far as its knowledge extended, they are generally valid for the world as a whole. The stress is laid on the need for adapting technology to man, not man to technology. The questions formulated in this report—and which merit attention in current discussions on the expansion of both technical and technological education in Great Britain—are raised in the belief that mastery of the machine by man is not an end in itself: it is a means to the development of man and of the whole society.

The distinction between technician and technologist is not always kept clear in this report, particularly in the chapter on the content of technical education. Nevertheless, the report directs attention to some fundamental issues which no sound policy for either type of education can disregard. In both fields it must be recognized that we are concerned not simply with the efficiency of production, but also with the fundamental attitude which the men and women of to-morrow will adopt in facing the problems of a technological society. Both, too, in seeking to foster flexibility, must recognize that flexibility is determined not only by education and training but also by social, economic and technical conditions; and the administrative measures required to ensure that education becomes more adapted to the needs of a changing technological society are themselves likely to be most effective when they are informal and varied rather than concentrated and uniform. The administrator, no less than the teacher and student, has need of frequent opportunities of contact with the industrial world, and requires experience of the difficulties and problems created by technological development in society; just as the teacher and student should keep abreast of developments in research and of practical applications in industry.

* Education in a Technological Society: a Preliminary International Survey of the Nature and Efficacy of Technical Education. (Tensions and Technology Series.) Pp. 76. (Paris: Unesco; London: H.M.S.O., 1952.) 200 francs; 4*s.*; 75 cents.

GENETICAL IMPLICATIONS OF THE STRUCTURE OF DEOXYRIBONUCLEIC ACID

By J. D. WATSON and F. H. C. CRICK

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THE importance of deoxyribonucleic acid (DNA) within living cells is undisputed. It is found in all dividing cells, largely if not entirely in the nucleus, where it is an essential constituent of the chromosomes. Many lines of evidence indicate that it is the carrier of a part of (if not all) the genetic specificity of the chromosomes and thus of the gene itself.

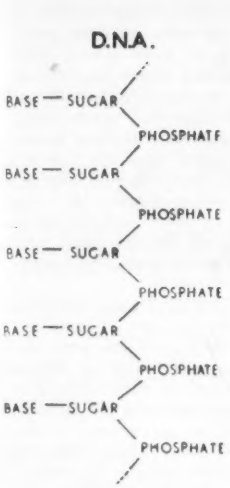

Fig. 1. Chemical formula of a single chain of deoxyribonucleic acid

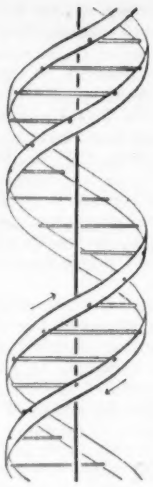

Fig. 2. This figure is purely diagrammatic. The two ribbons symbolize the two phosphate-sugar chains, and the horizontal rods the pairs of bases holding the chains together. The vertical line marks the fibre axis

Until now, however, no evidence has been presented to show how it might carry out the essential operation required of a genetic material, that of exact self-duplication.

We have recently proposed a structure[1] for the salt of deoxyribonucleic acid which, if correct, immediately suggests a mechanism for its self-duplication. X-ray evidence obtained by the workers at King's College, London[2], and presented at the same time, gives qualitative support to our structure and is incompatible with all previously proposed structures[3]. Though the structure will not be completely proved until a more extensive comparison has been made with the X-ray data, we now feel sufficient confidence in its general correctness to discuss its genetical implications. In doing so we are assuming that fibres of the salt of deoxyribonucleic acid are not artefacts arising in the method of preparation, since it has been shown by Wilkins and his co-workers that similar X-ray patterns are obtained from both the isolated fibres and certain intact biological materials such as sperm head and bacteriophage particles[2,4].

The chemical formula of deoxyribonucleic acid is now well established. The molecule is a very long chain, the backbone of which consists of a regular alternation of sugar and phosphate groups, as shown in Fig. 1. To each sugar is attached a nitrogenous base, which can be of four different types. (We have considered 5-methyl cytosine to be equivalent to cytosine, since either can fit equally well into our structure.) Two of the possible bases—adenine and guanine—are purines, and the other two—thymine and cytosine—are pyrimidines. So far as is known, the sequence of bases along the chain is irregular. The monomer unit, consisting of phosphate, sugar and base, is known as a nucleotide.

The first feature of our structure which is of biological interest is that it consists not of one chain, but of two. These two chains are both coiled around a common fibre axis, as is shown diagrammatically in Fig. 2. It has often been assumed that since there was only one chain in the chemical formula there would only be one in the structural unit. However, the density, taken with the X-ray evidence[2], suggests very strongly that there are two.

The other biologically important feature is the manner in which the two chains are held together. This is done by hydrogen bonds between the bases, as shown schematically in Fig. 3. The bases are joined together in pairs, a single base from one chain being hydrogen-bonded to a single base from the other. The important point is that only certain pairs of bases will fit into the structure. One member of a pair must be a purine and the other a pyrimidine in order to bridge between the two chains. If a pair consisted of two purines, for example, there would not be room for it.

We believe that the bases will be present almost entirely in their most probable tautomeric forms. If this is true, the conditions for forming hydrogen bonds are more restrictive, and the only pairs of bases possible are :

adenine with thymine ;
guanine with cytosine.

The way in which these are joined together is shown in Figs. 4 and 5. A given pair can be either way round. Adenine, for example, can occur on either chain ; but when it does, its partner on the other chain must always be thymine.

This pairing is strongly supported by the recent analytical results[5], which show that for all sources of deoxyribonucleic acid examined the amount of adenine is close to the amount of thymine, and the amount of guanine close to the amount of cytosine, although the cross-ratio (the ratio of adenine to guanine) can vary from one source to another. Indeed, if the sequence of bases on one chain is irregular, it is difficult to explain these analytical results except by the sort of pairing we have suggested.

The phosphate-sugar backbone of our model is completely regular, but any sequence of the pairs of bases can fit into the structure. It follows that in a long molecule many different permutations are possible, and it therefore seems likely that the precise sequence of the bases is the code which carries the genetical information. If the actual order of the

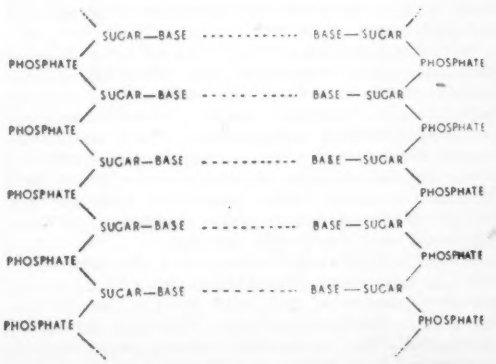

Fig. 3. Chemical formula of a pair of deoxyribonucleic acid chains. The hydrogen bonding is symbolized by dotted lines

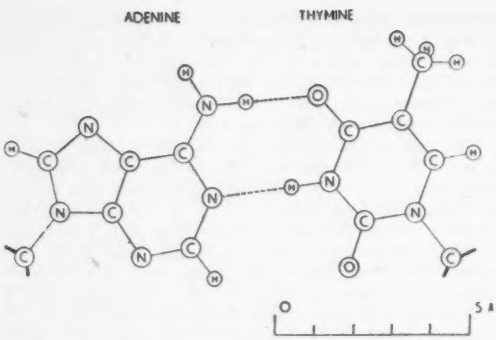

Fig. 4. Pairing of adenine and thymine. Hydrogen bonds are shown dotted. One carbon atom of each sugar is shown

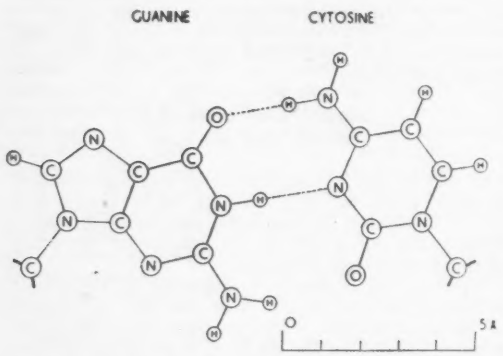

Fig. 5. Pairing of guanine and cytosine. Hydrogen bonds are shown dotted. One carbon atom of each sugar is shown

bases on one of the pair of chains were given, one could write down the exact order of the bases on the other one, because of the specific pairing. Thus one chain is, as it were, the complement of the other, and it is this feature which suggests how the deoxyribonucleic acid molecule might duplicate itself.

Previous discussions of self-duplication have usually involved the concept of a template, or mould. Either the template was supposed to copy itself directly or it was to produce a 'negative', which in its turn was to act as a template and produce the original 'positive' once again. In no case has it been explained in detail how it would do this in terms of atoms and molecules.

Now our model for deoxyribonucleic acid is, in effect, a *pair* of templates, each of which is complementary to the other. We imagine that prior to duplication the hydrogen bonds are broken, and the two chains unwind and separate. Each chain then acts as a template for the formation on to itself of a new companion chain, so that eventually we shall have *two* pairs of chains, where we only had one before. Moreover, the sequence of the pairs of bases will have been duplicated exactly.

A study of our model suggests that this duplication could be done most simply if the single chain (or the relevant portion of it) takes up the helical configuration. We imagine that at this stage in the life of the cell, free nucleotides, strictly polynucleotide precursors, are available in quantity. From time to time the base of a free nucleotide will join up by hydrogen bonds to one of the bases on the chain already formed. We now postulate that the polymerization of these monomers to form a new chain is only possible if the resulting chain can form the proposed structure. This is plausible, because steric reasons would not allow nucleotides 'crystallized' on to the first chain to approach one another in such a way that they could be joined together into a new chain, unless they were those nucleotides which were necessary to form our structure. Whether a special enzyme is required to carry out the polymerization, or whether the single helical chain already formed acts effectively as an enzyme, remains to be seen.

Since the two chains in our model are intertwined, it is essential for them to untwist if they are to separate. As they make one complete turn around each other in 34 A., there will be about 150 turns per million molecular weight, so that whatever the precise structure of the chromosome a considerable amount of uncoiling would be necessary. It is well known from microscopic observation that much coiling and uncoiling occurs during mitosis, and though this is on a much larger scale it probably reflects similar processes on a molecular level. Although it is difficult at the moment to see how these processes occur without everything getting tangled, we do not feel that this objection will be insuperable.

Our structure, as described[1], is an open one. There is room between the pair of polynucleotide chains (see Fig. 2) for a polypeptide chain to wind around the same helical axis. It may be significant that the distance between adjacent phosphorus atoms, 7·1 A., is close to the repeat of a fully extended polypeptide chain. We think it probable that in the sperm head, and in artificial nucleoproteins, the polypeptide chain occupies this position. The relative weakness of the second layer-line in the published X-ray pictures[3a,4] is crudely compatible with such an idea. The function of the protein might well be to control the coiling and uncoiling, to assist in holding a single polynucleotide chain in a helical configuration, or some other non-specific function.

Our model suggests possible explanations for a number of other phenomena. For example, spontaneous mutation may be due to a base occasionally occurring in one of its less likely tautomeric forms. Again, the pairing between homologous chromosomes at meiosis may depend on pairing between specific bases. We shall discuss these ideas in detail elsewhere.

For the moment, the general scheme we have proposed for the reproduction of deoxyribonucleic acid must be regarded as speculative. Even if it is correct, it is clear from what we have said that much remains to be discovered before the picture of genetic duplication can be described in detail. What are the polynucleotide precursors? What makes the pair of chains unwind and separate? What is the precise role of the protein? Is the chromosome one long pair of deoxyribonucleic acid chains, or does it consist of patches of the acid joined together by protein?

Despite these uncertainties we feel that our proposed structure for deoxyribonucleic acid may help to solve one of the fundamental biological problems—the molecular basis of the template needed for genetic replication. The hypothesis we are suggesting is that the template is the pattern of bases formed by one chain of the deoxyribonucleic acid and that the gene contains a complementary pair of such templates.

One of us (J. D. W.) has been aided by a fellowship from the National Foundation for Infantile Paralysis (U.S.A.).

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GEOPHYSICAL AND METEOROLOGICAL CHANGES IN THE PERIOD JANUARY–APRIL 1949

IN a recent article[1] Lewis and McIntosh have considered the geophysical data for the period January–April 1949, which we presented in an earlier communication[2]. On the basis of certain probability criteria they appear to show that the apparent regular variations in ionospheric and meteorological phenomena which occurred in that period were not significant. We have studied their article and made a separate statistical analysis of the *unsmoothed* data, and conclude that in all respects our original suggestions seem to be valid.

In our original article we presented graphs showing five-day moving averages in four parameters: (*a*) ground pressure, p; (*b*) E-layer critical frequency, fE; (*c*) F-layer critical frequency, $fF2$; and (*d*) K-index of geomagnetic activity. The connexion between ionospheric and geomagnetic phenomena is well known. Thus, Appleton and Ingram[3] in 1935 established the correlation between geomagnetic activity and depressions in $fF2$. It is worthy of note that in the period under discussion the inverse correlation between K and $\Delta fF2$ is, as Lewis and McIntosh point out, considerably less striking than that between p and ΔfE (cf. Figs. 1 and 2 in our original article). It would seem, then, that if statistical analysis can be successfully applied to show that there is no significance between the variations in p and ΔfE, it is, *a fortiori*, evident that a similar analysis might, in the present instance, be used for discrediting the established relationship between K and $\Delta fF2$. Conversely, of course, the fact that a phenomenon appears to be statistically significant over a short period must likewise be treated with reserve. The need for the utmost care in the application and interpretation of statistical analyses to such a limited time series is thus clear.

From inspection of our graphs it seemed to us that, so far as p and ΔfE were concerned, the period was unusual in three respects: (i) there appeared to be four oscillations in ground pressure showing a progressive diminution of amplitude, with an average period of about 27 days; (ii) in like manner there appeared to be four marked oscillations of period about 27 days in ΔfE; (iii) oscillations (i) and (ii) appeared to be almost exactly out of phase. In addition, we noted that the period was characterized by an unusual 27-day recurrence of great sudden commencement (S.C.) magnetic storms.

In our original communication we merely directed attention to these matters, and suggested that there might be some connexion between them. We did not then suggest, nor do we now suggest, that from a period of length only four months any conclusions can be drawn regarding the general behaviour over a long period of any of the geophysical parameters considered. The severely limited number of observations available, together with the fact that there is considerable uncertainty about the correct statistical approach to time series analysis, seemed to us sufficient reason for not entering into an extended statistical analysis.

However, the contrary conclusions reached by Lewis and McIntosh (see below) have prompted us to re-examine the data. Briefly, their conclusions are: (i) the 27-day oscillation in ground pressure is of no significance, since the amplitude is no more than would be expected from mere chance considerations; (ii) the 27-day oscillation in ΔfE is probably significant; (iii) oscillations (i) and (ii) are exactly in anti-phase; (iv) there is no significant correlation coefficient between the p and ΔfE data; (v) our conclusions arise from smoothing of the data.

We shall now outline our own analysis. In various communications[4–6], Kendall has made it abundantly clear that most of the methods generally used for studying periodicities in time series (for example, periodograms, Fourier analysis, etc.) may yield very misleading results when applied to the kind of time series with which we are here concerned. He has also questioned the reliability of the usual significance tests for periodicities when applied in time series analysis. Kendall has shown that the most reliable approach is that of serial correlation coefficients as exhibited in the correlogram. He points out that although the correlogram may be insensitive, it does give a lower limit to the oscillatory effects, and that if it oscillates there is almost certainly some systematic oscillation in the primary series explored. Figs. 1 and 2 show the correlograms for Δp and ΔfE respectively for the period under consideration. In both of these the original *unsmoothed* data have been used.

It is important to note that there is a marked trend in the pressure data, and to eliminate this we have dealt with values of pressure departures, Δp (as with the fE data), rather than with the absolute magnitudes p. The oscillations in both correlograms are clear, with a maximum at 26–27 days in each case. These correlograms provide strong support for our original deductions (based, as they were, on simple inspection of graphs), and make it essential for us to repeat Lewis and McIntosh's calculations.

At the outset we must again stress that the pressure data exhibit a marked downward trend (approximately linear), and it is imperative initially to eliminate this before proceeding with any numerical analysis. It appears that Lewis and McIntosh have overlooked this point, and as a result have arrived at quite contrary conclusions. This will be clear from an examination of Table 1, in which we present the results of calculations made by us using (i) pressure, p, (ii) pressure departures, Δp, and (iii) fE departures, ΔfE. The nomenclature employed (c, φ, σ, etc.) is that used by Lewis and McIntosh.

Without going into details, it can be stated that there is little significant difference between the present results *using pressure*, p, and those given by Lewis and McIntosh. The slight differences in the values of amplitude c and first serial correlation coefficient r_1 are of no significance and can be ascribed to different ways of deducing the amplitude and phase

of a 27-day oscillation from data covering four such oscillations, or to rounding-off processes used in the calculations. However, the significance criteria P_S and P_F are very sensitive to small changes in the 'modified amplitude ratio' a', and the net values obtained by us are somewhat lower than those given by Lewis and McIntosh. In this calculation we have not eliminated the trend in the pressure values; the amplitudes, etc., really refer to oscillation about the arithmetic mean of all the data. Clearly, when there is a marked trend in the data, this is an incorrect procedure.

Table 1

	c	φ	σ	a	r_1	a'	P_S	P_F
(i) p	5·8 mb.	244°	8·8 mb.	0·47	0·65	0·25	0·033	0·201
(ii) Δp	6·8 mb.	251°	8·1 mb.	0·59	0·57	0·34	0·003	0·079
(iii) ΔfE	0·06 Mc./s.	63°	0·09 Mc./s.	0·49	0·29	0·37	0·0006	0·021

Table 2

	c	φ	σ	a	r_1	a'	P_S	P_F
Δp	7·4 mb.	271°	8·1 mb.	0·65	0·57	0·37	0·0008	0·029
ΔfE	0·07 Mc./s.	85°	0·09 Mc./s.	0·55	0·29	0·41	0·00015	0·004

Thus, when we eliminate the effect of the trend in the pressure data, it is seen that the modified amplitude ratio a' is now some 35–40 per cent larger, with the result that P_S and P_F are reduced by factors of more than ten. The present values of P_S and P_F, namely 0·003 and 0·079, may be compared with the 0·057 and 0·989 respectively given by Lewis and McIntosh. It is clear that, far from being a chance phenomenon, the amplitude of the 27-day pressure oscillation even on the Fisher probability criterion is nearly within the 5 per cent significance level. So far as the ΔfE calculation is concerned, our modified amplitude ratio a' is slightly larger than that deduced by Lewis and McIntosh, but this alone is sufficient to reduce both P_S and P_F by a factor of more than 2, such that P_F is now well within the 5 per cent significance level.

A careful examination of Figs. 1 and 2 shows that in each case the peak of the correlograms occurs nearer 26 than 27 days. Accordingly, we have repeated the above statistical analysis for Δp and ΔfE for the case of a 26-day oscillation. The results are summarized in Table 2.

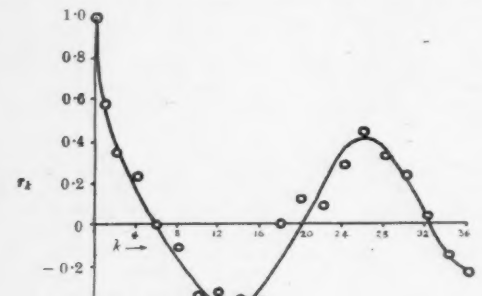

Fig. 1. Correlogram for pressure departures

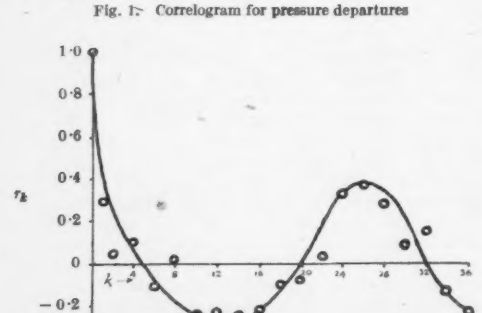

Fig. 2. Correlogram for fE departures

In this case, it will be seen that the amplitudes for both series are larger than in the 27-day case, and the values of the probability criteria are in all cases extremely small, indicating that the oscillations are indeed quite significant.

The three lines of approach which we have now considered—direct inspection of the original graphs, the correlograms of Figs. 1 and 2, and the statistical analysis outlined above—are in agreement, and all point to the reality of these 26–27-day oscillations *in this particular period*. We should add that we have examined data over many years of the kind considered above and have not found any similar period having such striking variations as characterized this particular 4-month period. It would seem that the large 27-day variations apparent here, and supported by statistical analysis, are probably of rare occurrence.

One further point might be considered. Apart from the fact that each series Δp and ΔfE separately exhibits a 26–27-day oscillation, it is also worth noting that the two oscillations are almost exactly in antiphase. The correlation coefficient between Δp and ΔfE for 105 available pairs is $-0{\cdot}37$. (In their analysis of p and ΔfE, Lewis and McIntosh used ninety pairs of correlates. The additional fifteen fE values used by us were obtained by interpolating missing noon values from measurements made at 1100 and 1300 hr.). In testing the significance of this correlation coefficient, we must make due allowance for the effect of coherence in the daily observations. This is usually done by reducing the number of observations by a factor ε (called the equivalent number of repetitions). Bartels[7] has given a relationship between ε and the successive serial correlation coefficients of a series (equation (2) of Lewis and McIntosh's paper). Using this, we obtain $\varepsilon \doteqdot 4$ for the Δp series, and $\varepsilon \doteqdot 2$ for the ΔfE series. The number of independent pairs must thus be taken as lying between 26 and 52. Using the approximation due to Fisher (quoted by Lewis and McIntosh), we then find a probability of 0·06 that 26 pairs will have a correlation coefficient $\geqslant 0{\cdot}37$; for 52 pairs the probability is 0·008. These figures are to be compared with the probabilities 0·436 and 0·148 respectively given by them. The considerable differences between these figures arise here, as in the Fourier analysis considered above, from the fact that they omitted to eliminate the trend in the pressure data. Concerning the values of ε, it might be argued that such a difference in degree of conservation is evidence against direct physical connexion between the parameters. However, too much significance should not be placed on the actual values, since (*a*) we have here only a very limited sample of data, and (*b*) the

accuracy of measurement of fE is somewhat less than that of p, and this diminished degree of accuracy in itself tends to reduce the calculated value of ε. The fact that the ε's are different and that the correlation coefficient between Δp and ΔfE is not particularly large may perhaps be taken to indicate that there is little direct physical connexion between the variations in p and fE, but that both might be affected by a common extraneous cause.

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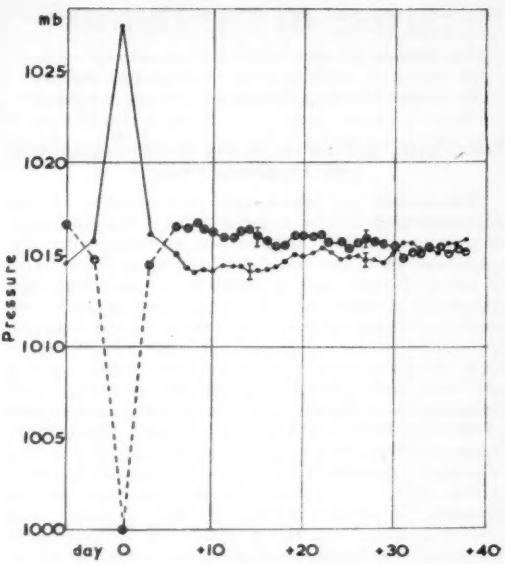
We should like to make the following comments on the communication by Beynon and Brown.

(1) The fact that the correlation between K indices and $fF2$ is not necessarily significant over the period under discussion cannot "discredit the established relationship", because this correlation is known to persist as more and more data are taken; the lack of significance is due to the smallness of the sample. (In fact, the correlation coefficient between $fF2$ and corresponding daily sums of K indices was $-0{\cdot}21$, that is, almost the same as that between p and ΔfE.)

(2) The use of correlograms adds nothing to the previous graphical representation of smoothed variations, since no numerical significance test is applied.

(3) The differences between our results and those obtained by Beynon and Brown result from their use of values of Δp rather than p. We did not overlook the fact that there is an apparent downward trend in the pressure data, but we did not on that account use Δp instead of p for the following reasons. The monthly means of fE closely depend on the sun's zenith angle, and the variation of fE with factors other than the sun's zenith angle is clearly best considered by taking departures (ΔfE) from the smooth curve joining the monthly means, as was done in both analyses. In contrast, pressure at Kew shows no annual variation ascribable to a simple physical cause: monthly means of p at Kew are widely scattered for corresponding months from year to year, and the long-period means show a small and irregular annual variation. An apparent 'trend' in any individual period is consequently as much a part of the true variability of p as are the 'departures' (Δp) from the 'trend', and should not be eliminated before applying numerical tests. (It may be remarked that in Beynon and Brown's original paper p, and not Δp, was plotted and discussed.)

(4) It is difficult to conceive the possible nature of a physical agency responsible for causing world-wide variations in fE and simultaneous—but geographically very restricted—large variations in surface pressure. We would re-emphasize that this difficulty makes it very necessary for the p and ΔfE variations to be shown to be much closer than may be explained by the method of choice of this particular period, namely, the sequence of four maxima in p at 27-day intervals. We consider the facts as presented in our analysis to be entirely compatible with a chance



Mean variation of Kew surface pressure at midday around 600 selected days of pressure-peak (●—●—) and of pressure-trough (○- -○- -) during 1926–50

general similarity of p and ΔfE with therefore no common physical cause.

(5) Independent evidence of the existence of a direct effect of variations of solar radiation on those of surface pressure is given by the results of a study we have made of pressure-recurrence tendencies. Our method followed that used so successfully by Chree and Stagg[1] for demonstrating the effect of the solar rotation period on geomagnetic disturbance. Two days of clearly defined mid-day pressure maximum at Kew were selected for each month in the period 1926–50. Independence was secured by ensuring that no two maxima in the whole pressure series were nearer than 7 days. The statistical variation of pressure was then determined from 6 days before to 38 days after the 600 selected pressure-peak days. The variation of pressure was also determined around 600 pressure-trough days selected in a similar way. The results are shown in the accompanying graph, in which the standard errors of the means are indicated.

The curves indicate complete randomness in the occurrence of lengths of interval separating pressure peaks and also in those separating pressure troughs. Subdivision of the data according to season and sun-spot epoch gave similar results. It may be noted in particular that in neither case is there evidence of any systematic pressure effect after an interval of about 27 days. The method of analysis is independent of changes of phase or intermittency. Beynon and Brown state that in many years they have found no recurrence of the large 27-day pressure variation: our result shows that an oscillation of about this length had no more than random occurrence during 1926–50.

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LETTERS TO THE EDITORS

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Functional Relations of the Adenohypophysis and Hypothalamus

The means by which the pars distalis of the adenohypophysis ('the anterior lobe of the pituitary' or 'anterior lobe') adjusts its secretions to the requirements of the body continue to be the subject of much inquiry and speculation. Apart from the reciprocal interaction of the anterior lobe with such endocrine organs as are under its control (for example, the adrenal cortex and gonads), it is generally accepted that the gland is able to respond to changes which are mediated through the nervous system. For example, it is known that the reproductive organs of the ferret, which in Great Britain breeds only between March and August, can be activated during the winter months if the animal is exposed to additional light. This response is dependent on the presence of (*a*) the retina, (*b*) the pituitary, and (*c*) the gonads, and the presumption is that nerve impulses, first transmitted along the optic pathways, in some way stimulate the anterior pituitary to secrete gonadotrophic hormone. Unfortunately, attempts to track the actual pathways by which the impulses are relayed from the optic pathways to the gland have in large part failed[1]. Moreover, while it is definitely established that the whole neurohypophysis is innervated by hypothalamic nuclei, there is no agreement that nerve fibres reach the pars distalis of the adenohypophysis from this region of the brain[2]. Such sympathetic and parasympathetic fibres as enter it on the walls of the blood-vessels are usually assumed to be mainly vasomotor in function[3].

Attention has recently been focused on the hypophysial-portal system of vessels as the controlling link between the pituitary and the hypothalamus, and in elaborating this view Harris has suggested[2,4] that impulses from the hypothalamus, which is connected by fibre tracts to most parts of the brain, stimulate the secretion of some 'chemotransmitter' substances within the median eminence in the floor of the third ventricle, and that these then pass down the portal vessels into the sinusoids of the anterior pituitary to modulate the activity of the secretory cells of the pituitary. Harris, whose experiments have been performed on rabbits and rats, also suggests that the persistence of normal anterior pituitary function after section of the pituitary stalk is due to the reconstitution of the portal vessels; and he indicates that pituitary function is scarcely likely to be normal if the vessels do not regenerate.

Some general issues which need to be resolved if this attractive hypothesis is to be sustained have been discussed elsewhere[5]. The present and preliminary note describes certain experiments which show that ferrets can become œstrous as a result of artificial illumination in the winter even after the elimination of the hypophysial-portal system of vessels.

In these experiments the pituitary stalk was divided by means of an operative procedure described elsewhere[6]. In some animals the stalk was just sectioned; in others a small fragment of muscle was gently inserted between the pituitary and the base of the brain; in a third series, a small piece of waxed paper was used instead of muscle. With few exceptions, histological examination showed that the paper had been eliminated from the wound some time between the operation and autopsy.

Seven of twenty-three ferrets submitted to these procedures, and in which the stalk had been completely sectioned (with the consequent disappearance of the processus infundibularis), failed to come into heat when illuminated by means of electric light during the winter months. In all these animals the distal end of the proximal stump of the stalk had become either adherent to the superior surface of the anterior part of the pituitary, or closely connected to it by reaction tissue. In both cases there was a clear anastomosis between the vessels in the two structures. In most of these seven animals the pars distalis was smaller than normal, and the arrangement of its constituent cells also appeared abnormal.

The remaining sixteen animals came into heat. In six, histological examination of the base of the brain and the sella turcica showed that the stalk had been incompletely severed, and that the processus infundibularis had not involuted. In the remaining ten, the stalk had been completely divided, and the processus infundibularis had disappeared. In most of these the proximal stump had either become adherent to the pars distalis, or the two had become connected by means of reaction tissue. In a few of these it could safely be said that the vessels in the stalk, including portal vessels, had re-established a connexion with the sinusoids of the pars distalis. In others, the anastomosis was more doubtful, and it was possible that, in addition to communicating with the sinusoids, vessels of the stalk were also anastomosing directly with veins in the surrounding fibrous tissue, and thus with neighbouring dural sinuses.

In one critical case, however, the pars tuberalis had been so severely damaged that it was neither possible to recognize cells which could be designated as tuberalis cells, nor the primary loops of the portal vessels. In another ferret, paper, new bone and fibrous tissue intervened between the pituitary gland and the part of the brain anterior to the base of the stalk, there being no trace of any vascular connexion between the two. Both these animals reacted to light by becoming œstrous.

A detailed account of these experiments will be published elsewhere. They show that the gonads of the ferret will respond to additional light during the winter, when there appears to be no possibility of impulses emanating in the retina being transmitted via the hypothalamus to the pars distalis of the pituitary, either directly by a nervous pathway, or indirectly, through the pituitary-portal system of vessels. Our experiments do not give any indication of the way in which the response is mediated, and we are continuing our study of this essential problem.

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Therapeutic Action of Glutathione and Mercaptoethylamine against a Lethal Dose of X-Rays

It has been shown that the shielding of the liver *in situ* protects 73 per cent of a group of rats against a dose of X-rays which is 100 per cent lethal after fifteen days for the control animals[1]. E. S. G. Barron[2] showed that glutathione had a protective action in mice when injected before the lethal irradiation. Bacq and his co-workers[3] have shown that β-mercaptoethylamine protects mice against a lethal dose of X-rays when this compound is injected into the animals immediately before the total body irradiation. We have been able to confirm these results in rats[4]. On the other hand, the β-mercaptoethylamine is completely inactive when given even immediately after the exposure to a lethal dose.

The purpose of this short communication is to show the therapeutic action of reduced glutathione and of β-mercaptoethylamine against a lethal irradiation when the rats have the liver area shielded during the exposure. Six groups of twenty-four rats each have been irradiated over the entire body with a dose of 1·130 r. measured with the Victoreen X-ray condenser r.-meter. The apparatus used is a 250-kV. Maximar X-ray machine of the General Electric Co. The distance anticathode – animal is 55 cm., the voltage 180 kV., 15 m.amp., with no secondary filter. The first group of rats was irradiated over the entire body. A second group received the same dose, the liver area being shielded with a lead foil of 5 mm. thickness protecting an area of 5 cm. × 3 cm. corresponding to the liver region. A third group was irradiated as the second group (liver region protected); but the animals were injected immediately after the irradiation, 6 hr. and 12 hr. later, with an intraperitoneal dose of 7 mgm. of β-mercaptoethylamine. The fourth group was irradiated over the whole body like the first group but injected with β-mercaptoethylamine as the animals of the third group. The fifth group was irradiated as the second group (liver region protected), but the animals were injected intraperitoneally with 12 mgm. of reduced glutathione immediately after the irradiation, 6 hr. and 12 hr. later. The sixth group was irradiated over the whole body like the animals of the first group, but were injected with reduced glutathione as were the animals of the fifth group. The number of survivors is shown in the accompanying table.

This type of experiment was carried out twice with the same general results, and shows that reduced glutathione and β-mercaptoethylamine have a therapeutic action when injected into rats exposed to a lethal body-dose of X-rays if the liver area is shielded during the exposure.

We have repeated the experiment with rats having an equivalent area of the costal region protected during the irradiation. In such conditions β-mercaptoethylamine has practically no therapeutic action.

Group	I	II	III	IV	V	VI
Dose	1,130 r. alone	1,130 r. + lead shield on liver	1,130 r. + lead shield on liver +3×7 mgm. mercaptoethylamine	1,130 r. +3×7 mgm. mercaptoethylamine	1,130 r. + lead shield on liver +3×12 mgm. glutathione	1,130 r. + glutathione
No. of animals	24	24	24	24	24	24
Days after X-rays						
7	4	16	20	3	24	1
14	0	8	18	0	18	0
21	0	7	15	0	17	0
30	0	5	14	0	11	0

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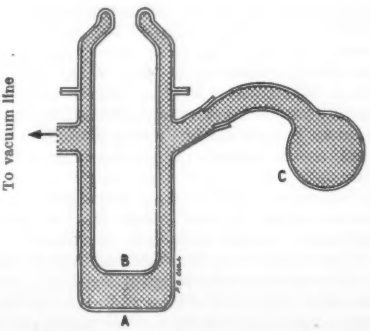
A Simple Tissue Freeze-drying Apparatus using the Principle of Short-path Sublimation

With increasing recognition of the advantages of the freezing and drying of tissues for cytochemical studies, it is of interest to describe a cheap and efficient drying apparatus which has been in continuous use during the past two years.

The dryer works on the principle of short-path sublimation[1] and is constructed of 'Pyrex' glass. The quenched tissue is placed in the bottom of the drying chamber (*A*), which is immersed in an ethyl oxalate/solid carbon dioxide mixture giving a temperature of − 40° C. The top of the chamber is then placed in position and the system evacuated by a commercial diffusion pump and a rotary pump. The condensing finger is then filled with liquid air or nitrogen, which cools the condensing surface *B*, placed 3 cm. away from the tissues. The operating pressure is 10^{-4} to 10^{-5} mm. mercury, giving a mean free path for the water molecules of about 50 cm. This permits straight-path sublimation of the water molecules from the specimens to the condenser. At the end of the drying time, the drying chamber is slowly warmed by hot water to a temperature just above the melting point of the embedding wax used. The



previously degassed wax in *C* is just melted and then poured on the tissue by rotating *C* in its socket. After a short interval, the vacuum is released and the tissues blocked out.

In our original model the embedding wax was a lining to the bottom of the drying chamber during the drying cycle; but it acted as a thermal insulator between the bath and the tissues and also required a long time to melt when embedding.

Mouse tissues such as liver, kidney, gut, spleen and pancreas can be dried in seven hours at − 40° C.; but in our hands human tissue (post-mortem) requires twenty-four hours drying for the best results. This need for longer drying times may be due to post-mortem changes, and biopsy material may dry quicker. Fatty materials, such as some skins and also ovary, require a longer drying time. When it is necessary to dry overnight, the cold trap is filled with very finely powdered solid carbon dioxide and a little acetone added. In this way the trap remains cold for at least fourteen hours, whereas the usual acetone/carbon dioxide mush does not last as long. As a precaution against accidents, the apparatus is shielded in use by wire gauze. If short drying times are not essential, the diffusion pump may be dispensed with.

The main advantages of this dryer compared with other recently described designs[2] are its cheapness, robustness and simplicity.

We wish to thank Mr. V. C. Conlay for his helpful criticism.

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The Ratio Molars/Premolars in Perissodactyls

In the course of a study of the European *Hipparion*[1], it was found that the ratio of the length of the molar series to the length of the premolar series (M/P) is fairly constant within that genus. It ranges from 76·7 to 91 ($M/P \times 100$) in thirty-eight specimens of upper tooth-rows from Pikermi and Salonica, most values falling between 80 and 89. It appears to be independent of the length of the tooth-row.

From Osborn's review of the American Equidæ[2], approximate values of the index $M/P \times 100$ have been estimated for the principal members of that family. The first of them (*Mesohippus* and *Miohippus*) show some high indices (96–109); but, in those primitive types, if P^1 is included in the premolar series, the index falls to the range of values

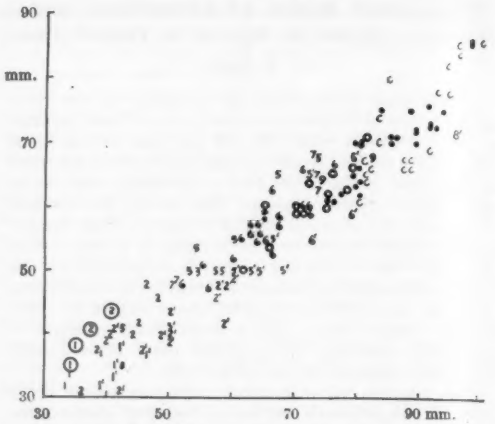

Fig. 1. Ratio molars/premolars in the Equidæ. Ordinate: molars; abscissa: premolars. 1, *Mesohippus*; 2, *Miohippus*; 3, *Kalobathippus*; 4, *Anchiterium*; 5, *Parahippus*; 6, *Merychippus*; 7, *Protohippus*; 8, *Pliohippus*; 9, *Hypohippus*; black dots, *Hipparion* from Pikermi; circles, *Hipparion* from other localities; *C*, *Equus caballus*; 1′, 2′. . . ., as above, but P^1 included

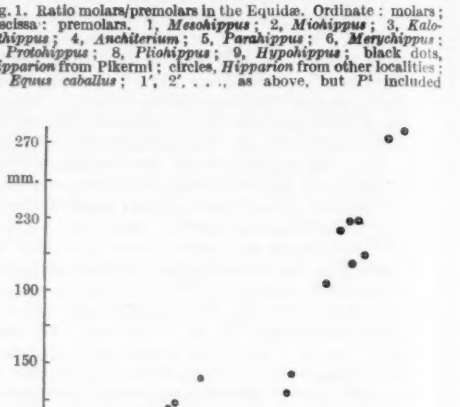

Fig. 2. The same ratio as in Fig. 1 in the Titanotheridæ (circles) and in the Equidæ. Black dots, *Hipparion*. Ordinate: molars; abscissa: premolars

found in more advanced forms (about 78–90) or even lower. Thus, the ratio M/P has tended to remain constant despite the loss of the first premolar; in other words, the series $P^2 + P^3 + P^4$ is playing in later forms the part of $P^1 + P^2 + P^3 + P^4$ in earlier forms (Fig. 1).

That some individuals of *Mesohippus* and *Miohippus* have indices higher than 100 suggests that there may have been a trend which has been very soon abandoned by the Equidæ. This earlier trend may have been retained in other families of Perissodactyls. Indeed, in the Titanotheridæ, as described by Osborn[2], the evolution of the dentition has followed a course opposite to that seen in the Equidæ. The index $M/P \times 100$ is always greater than 100, and often reaches about 200. That the two families, at first near each other, have steadily diverged in the

course of their respective evolutions, may be shown by plotting the lengths of the series as in Fig. 2.

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Light Emission and Light Perception in Species of *Diadema*

THAT echinoderms are sensitive to light has been generally agreed, but the nature of their photoreceptors has been the subject of many conflicting statements, sometimes based wholly on inadequate evidence. This is especially so in the echinoids, one family of which, the Diadematidæ, possesses several members which are strikingly sensitive to light[1–6]. Light emission has also been attributed to the species of *Diadema*[1,7], but this has also been questioned[1] and, in the case of *Diadema setosum* (Leske), denied[5].

I have examined several hundred individuals of varying ages, of the allied species *Diadema antillarum* Philippi, at various times of the day and year, but I have never seen any signs of phosphorescence. There is a striking iridescence on the test, however, especially in young forms, appearing in bright light as thin lines[8–10] or spots of brilliant blue which correspond closely in distribution with the similar iridescent spots described in *D. setosum*[1,4], and with the areas that have been described as phosphorescent[7].

In sections through the test of *D. antillarum*, these areas are distinguished by the presence of the remarkable organs shown in Figs. 1 and 2. Each is composed of single or clustered units containing more-or-less regularly arranged plates (*pl.*) which at once recall those of iridophores[11]. It seems likely that the plates are responsible for the iridescence, which is probably intensified by the dispersion of melanin in the superjacent processes of melanophores (*ch.*).

The blue spots in *D. setosum*, however, have been described as eyes[1,4,5], and to them has been attributed the sensitivity to light. Sarasin, F., and Sarasin, P., have described and figured highly differentiated compound photoreceptors, each unit with cornea, lens and retina[4]. Their ideas have been widely accepted and their figures appear in standard zoological text-books, despite some hesitancy as to their accuracy[1,12].

In *D. antillarum*, which is extremely sensitive to light[6], I can find nothing corresponding to a lens or a retina in these structures, which are much more reminiscent of clusters of iridophores than of eyes, a suggestion that agrees well with the iridescence observed in the areas where they are located.

Experimental evidence as to the relative sensitivity to light of various parts of the surface gives no support to the idea that these structures are eyes; for, using the production of the spine reflex[6] as an index of sensitivity toward changes in intensity of illumination, it is found that, on obliterating minute light spots projected on to various parts of the surface, the whole surface of the test (including the swollen spine bases) is sensitive to such changes, but the parts bearing the blue lines or spots are much the least sensitive[6]. If, therefore, these are photoreceptors, they are clearly not significantly involved as such in the animal's most striking and characteristic response to light.

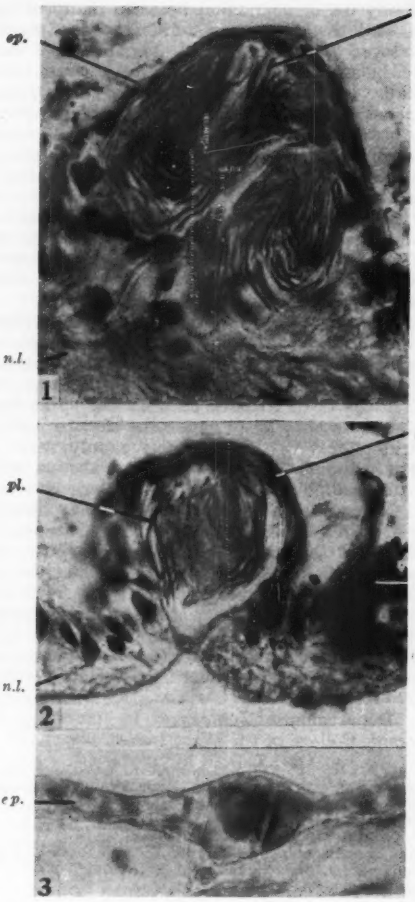

Fig. 1. Vertical section through a cluster of iridophores from a young *Diadema antillarum* (ambital diameter of test, 1·3 cm.), fixed Bouin, stained by Masson's method for the argentaffine reaction, counterstained Mallory's triple stain. Approx. × 500

Fig. 2. Vertical section through a single iridophore of the same individual showing the accompanying melanophore (*ch.*), the contents of which can be seen to have been partly discharged by the action of the fixative. Fixation and staining as above. Approx. × 500

Fig. 3. Vertical section through a developing iridophore from the interambulacrum of a very young *Diadema antillarum* (diameter of test at ambitus, 2·5 mm.). Compare with foregoing and note absence of a recognizable superficial nerve layer. Fixed Bouin, stained Delafield's hæmatoxylin and eosin. Approx. × 500

ch., melanophore; *ep.*, epidermal layer covering test; *n.l.*, superficial nerve layer beneath epidermis; *pl.*, plate-like structure within iridophore

Fully in agreement with this is the recent discovery that a very young form (diameter of test 2·5 mm.), in which the iridescent areas were few and very imperfectly formed (Fig. 3), showed a clear response to shading on the part of the spines, pedicellariæ and suckered tube feet; though it must be admitted that the spine jerks were feeble and lacked the co-ordination characteristic of older forms. Moreover, so far as ordinary histological methods (fixation in Bouin's fluid followed by staining in hæmatoxylin and eosin) may be considered of value, they fail to

reveal any direct connexion between many of these organs and the nervous system, for the superficial nerve layer (*n.l.*) so readily demonstrable immediately beneath them in older forms by a similar technique is apparently incomplete and missing from considerable areas of the interambulacra (Fig. 3) which bear these structures. It is highly significant that the absence of special nerves to the organs, in older individuals of *D. setosum*, has been mentioned by authors who regarded them as eyes[4].

For the present, therefore, I find no good reason for regarding these structures in *D. antillarum* as eyes, and in view of the obvious close relationship between *D. antillarum* and *D. setosum*, the matter clearly requires re-investigation in the latter form.

It is suggested that the organs in *D. antillarum* are iridophores, and reflect light on to the neighbouring areas which are more sensitive to changes in light intensity. This function would be especially useful in the deep recesses between the spine bases, and it is here that large masses of them are found. The iridophores would be effective only when the melanin in the chromatophores (which always accompany the iridophores (*ch.*, Fig. 2)) is largely concentrated; for when fully dispersed, the iridophores are covered. This would perhaps, in part, account for the fact that the animal becomes more sensitive to shading as the light fades, for it is then that the melanin becomes concentrated[10]. If the spine reflex is regarded as part of the general defensive reaction set off by the shadow of a potential enemy falling on the light-sensitive surface, the significance of increased sensitivity in fading light becomes obvious.

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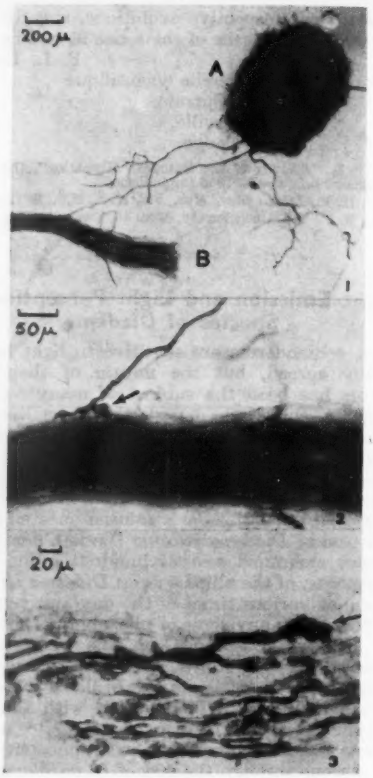
Fructifications associated with Mycorrhizal Strawberry Roots

Root infections by vesicular-arbuscular mycorrhizal fungi have been reported in many plants for more than half a century. With the exception of one unconfirmed report, reproductive stages of these fungi have not been described[1]. Numerous attempts to isolate the fungus from infected tissue have been unsuccessful, and mycelial transplants unattached to a piece of infected plant tissue have never survived[2]. Butler[3] pointed out the close relationship of the vesicular-arbuscular mycorrhizal fungi to the Endogonaceæ, and concurred with Peyronel's view that they are probably members of this family.

In 1951, fructifications of the Endogone type were found attached to mycorrhizal strawberry roots grown in pots. The presence of hyphal connexions between these fructifications and the mycorrhizal fungus inside the strawberry roots has been clearly established (Figs. 1–3). The fructifications appear



(1) Hyphal connexion between fructification (*A*) and strawberry root (*B*).
(2) Enlargement of connecting hypha at point of entry into root.
(3) Longitudinal section of the same root showing connecting hypha at point of entry, and its continuity with the mycorrhizal fungus inside the root. Arrows in (2) and (3) mark identical parts of the fungus

as light-brown spherical bodies, up to 1 mm. in diameter. They consist of a loose weft of hyphæ containing usually two to six, but sometimes up to thirty-two small spores, 92–197 μ in diameter. The spores are distributed at random inside the weft. Mature spores are yellow to brown, with a thick endospore and a thin exospore wall. This, according to Kanouse[4], is a characteristic of the Endogonaceæ.

Inoculation experiments are in progress to synthesize mycorrhiza under controlled conditions, using the fruit bodies and sterilized spores excised from these to provide the fungus constituent. In these experiments some typical mycorrhizal infections have been obtained in strawberry seedlings grown in test-tubes in soil sterilized by autoclaving and with propylene dioxide. Attempts are also being made to germinate the excised spores on artificial media. The results of these experiments will be reported elsewhere.

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Aggregation in Cellular Slime Moulds: *in vitro* Isolation of Acrasin

In *Dictyostelium* and *Polysphondylium*, members of the Acrasieæ, there is an aggregation stage in which previously independent amœboid cells stream towards certain cell clumps, which thus act as collecting centres, and there form communal fruiting bodies[1]. Communication between the centres and the reacting cells is through the external medium. Bonner[2] produced indirect evidence that a chemical diffused outwards from the centres, setting up a concentration gradient by which the separate cells oriented themselves; pointing out that isolation *in vitro* would be the final proof of the chemical's existence, he named it 'acrasin'.

Pfützner-Eckert[3] claimed that sensitive amœbæ of *D. mucoroides* would move towards a cell-free block of agar on which centres had rested. My own repeated attempts to get orientation to an artificial gradient set up by such an agar block, or by drops of water which had bathed centres and then been absorbed on agar or sucked up a capillary tube, were unsuccessful. Theoretical arguments and experimental observations both suggested that acrasin was short-lived, the active molecules probably having a mean life of a few minutes. If this were so, it would be necessary to renew the head of an artificial gradient at frequent intervals in order to demonstrate orientation. This was finally achieved by sandwiching amœbæ between an agar block and a glass slide; drop by drop, washings from living centres were then rapidly and continually transferred to the meniscus around the block, whence the acrasin they contained diffused into the interior. Chemotaxis now occurred, sensitive cells moving not towards a point, as in normal aggregation, but parallel to each other towards the nearest edge.

To study the stability of acrasin, the washings were kept for short periods before adding them to the meniscus: if kept 1 min., attraction was strong; if 5 min., weak; if 15 min., absent. The washings unavoidably contained a few loose cells from the centres, and there was scarcely sufficient time to remove them by centrifuging; but the fact that the reacting amœbæ, unless they had formed an autonomous organization, became disoriented immediately I stopped adding washings to the meniscus made it unlikely that loose cells which had been carried over were playing any part in setting up the gradient. It was later found that if the washings were frozen within a few seconds of collection their activity was retained indefinitely, though lost as rapidly as before when they were returned to room temperature. No viable cells survived severe freezing.

A test for the presence of acrasin and a means of preserving it made possible a wide variety of experiments. Studies were made of conditions under which acrasin was secreted; the changes in sensitivity of reacting amœbæ; and the rate of decay of acrasin at different temperatures. No evidence could be obtained that acrasin was stored in centres.

As two mixed species of *Dictyostelium* form joint aggregations, whereas when *Dictyostelium* is grown with *Polysphondylium* each genus forms its own[4], it might be expected that acrasin would be genus-specific. I examined *D. discoideum*, *D. mucoroides*, *D. giganteum*, *D. purpureum* and *P. violaceum*. *Dictyostelium* amœbæ of any species responded, as expected, to washings obtained from any *Dictyostelium* centre; but they also oriented themselves to washings from *P.* centres. This seemed to indicate that acrasin was not specific; but further work showed that specific *Polysphondylium*- and *Dictyostelium*-acrasins, which oriented the corresponding cells, did in fact exist. Young *P.* centres and streams made only *P*-acrasin and attracted only *P.* cells. At a certain stage of development, *P.* centres began to make *D*-acrasin too and then attracted both *P.* and *D.* cells; for technical reasons, only centres of this later stage could be bathed to yield acrasin solution, and this oriented both cell types. *D.* centres did not attract *P.* cells, except old ones at short range; probably *D.* centres made only *D*-acrasin, which had a weak effect on specially sensitive *P.* cells. The behaviour of *P.* centres was remarkable, for as they began to make *D*-acrasin their production of *P*-acrasin fell off; that is, they manufactured a foreign chemical, to which most *P.* cells were chemotactically insensitive, apparently at the expense of their own. It may be that *D*-acrasin takes some other role, as yet unknown, in both genera; whatever the explanation, the distribution of sensitivities and powers of synthesis suggest that *Polysphondylium* evolved from *Dictyostelium*; this is consistent with the morphological evidence.

Sussman and Noël[5], and Sussman[6], have shown that initiation of aggregation is a special process, and this confirms my own views based on quite different evidence. Once it is recognized that different acrasins are made at different stages of development, the possibility must be considered that some initiation factors are further slight modifications of the basic acrasin molecule.

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Intolerance of Dizygotic Twin Lambs to Skin Homografts

It has been shown that homografts exchanged between dizygous cattle twins may often survive indefinitely in spite of the fact that grafts exchanged between full siblings other than twins, or between calves and dam, have not been found to survive more than twenty days after transplantation[1,2]. This anomalous tolerance on the part of dizygous cattle twins is thought to have the same origin as their conformity of red-cell agglutination types[3,4], namely, the confluence of their fœtal circulations. The purpose of the present inquiry was to determine whether dizygous sheep twins are also tolerant to grafts of each other's skin.

The same methods were used as have been described for cattle[2]. Pinch grafts were taken from the shaved dorsal surface of the ear and fitted into recesses cut to receive them in a shaved area of the animal's side, just below the withers. The grafts were covered with tulle gras, a layer of sterile gauze and a pad of cotton wool. These dressings were held in place by a 'Lastonet' bandage which completely surrounded the animal. The bandage was secured by rubber latex solution ('Copydex') and Michel suture clips. With cattle, a hessian covering is used for protecting the bandage;

but this was not thought necessary with sheep as their wool seemed to provide sufficient protection. At each operation site, a subcutaneous injection of 2–3 c.c. of 2 per cent ethocaine hydrochloride was given as an anæsthetic.

Two Scottish blackface ewes with twin lambs by a Cheviot ram or rams were available. The ewes were unrelated; but it is possible that all four lambs were half-sibs. The ewes were both about six years old. Ewe 27, dam of lambs ♀2*K*9 and ♂2*K*8, weighed 112 lb. and had lambed on March 29, 1952; ewe 129, dam of lambs ♀2*K*4 and ♀2*K*5, weighed 104 lb. and had lambed on March 26, 1952. All skin interchanges were made on April 30, 1952, when the lambs were about five weeks old.

Four grafts were put on to each animal in a square, thus:

1 2

3 4

On lambs, position No. 1 was occupied by an autograft, No. 2 by skin from an unrelated ewe, No. 3 by skin exchanged between dam and offspring, and No. 4 by skin exchanged between full-sib twins. On ewes, the arrangement was the same, except that position No. 4 was occupied by skin from the second lamb. The grafts on ewe 27 and her lambs behaved as shown in Table 1. The graft from the unrelated ewe 129 on to lamb 2*K*8 was lost by faulty healing, and the resulting scab obscured the fate of the neighbouring autograft.

Table 1

Recipients	Donors			
	Ewe 27	Lamb 2*K*9	Lamb 2*K*8	Unrelated ewe 129
Ewe 27	+	−	−	−
Lamb 2*K*9	−	+	−	−
Lamb 2*K*8	−	−	?	lost

+ indicates survival and − indicates a breakdown in 7–14 days

The parallel series of grafts on ewe 129 and her lambs gave the results shown in Table 2.

Table 2

Recipients	Donors			
	Ewe 129	Lamb 2*K*4	Lamb 2*K*5	Unrelated ewe 27
Ewe 129	Bandage slipped and all grafts lost			
Lamb 2*K*4	−	+	−	−
Lamb 2*K*5	−	−	+	−

Of the six independent autografts, all, except the two lost for technical reasons, survived. At the end of a month they were perfectly established and healthy. That on ewe 27 was particularly well defined, as it consisted of black ear skin and carried a good crop of hair easily distinguishable from wool. The remaining live autografts on the lambs consisted of white ear skin which was less conspicuous but carried white hair instead of wool and were readily differentiated from the scars left by the neighbouring homografts. All homografts broke down rapidly, and fourteen days after the operation only dry scabs remained. It has been assumed that the like-sexed pair is dizygous. This is justified by the established rarity of one-egg twins[5].

These observations make it improbable that, in sheep, homografts between dizygous twins will survive transplantation. Accordingly, skin interchange could be used as a highly critical test for monozygotic twinning in sheep. The intolerance to homografts shown by two-egg sheep twins contrasts with the tolerance shown by two-egg cattle twins, a difference which is no doubt associated with the fact that freemartins occur in cattle but not in sheep.

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Alteration of *p*H in the Sheep's Oviduct

During previous work on the oviduct of the sheep, evidence was obtained which suggested that a change of *p*H might be associated with the cyclical changes of mucin secretion[1] in this duct. In a further investigation the *p*H of the oviducts of seventy sheep, recovered at slaughter from the abattoir, was determined by using Lovibond's comparator. This material covered all stages of the œstrous cycle.

The oviducts were examined within 45–60 min. after death. One oviduct of each animal was washed out with 1 c.c. of double-distilled water, then a further amount of double-distilled water was added to the washing to bring the total amount of liquid to 10 c.c. The first ten oviducts showed a *p*H with the universal indicator between 6 and 7; therefore in all further work bromthymol blue (*p*H 6–7·6) and methyl red (*p*H 4·2–6·3) indicators were employed.

The investigations showed that the *p*H of the oviduct undergoes cyclical change which seems to correspond to the sexual cycle. Where the specimen was clearly in the di-œstrous stage, a *p*H of 6–6·4 was found, in pro-œstrus the *p*H rose to 6·4–6·6 and in œstrus and met-œstrus the *p*H ranged from 6·8 to 7·0. The phase of the cycle was determined by macroscopical examination of the ovary, and in the majority of specimens the follicle or corpus luteum permitted an accurate estimation to be made. In doubtful cases, however, it was found that the *p*H of the oviduct was more reliable than the naked eye diagnosis.

After standing for about two hours, it was found that the *p*H of the specimen fell to 6·2 regardless of the phase of the cycle and the temperature of the refrigerator.

The question arises whether this *p*H has any connexion with the conditioning factor[2] which enables the spermatozoa to penetrate the zona pellucida.

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The Shark, *Isurus oxyrinchus*, in South African Waters

THE isurid shark, *Isurus oxyrinchus* Rafinesque, 1810, although most closely related to the Indo-Pacific *I. glaucus* Müller and Henle, 1841, is apparently constantly and clearly differentiated in certain features, notably the height of the dorsal fin and the relative length of the head from snout tip to pectoral origin. Primarily of tropical and subtropical oceanic waters, this species has hitherto been known from a wide range in the Atlantic both east and west. It is extremely virile and vigorous, and is a game fish of repute much sought after by anglers.

Although known in mid-Atlantic at St. Helena, there has hitherto been no positive coastal record from West Africa south of about 12° N. The discovery of a specimen of undoubted *I. oxyrinchus* Rafinesque, off Algoa Bay (about lat. 34° S., long. 26° E.), is therefore of considerable interest. This is obviously a young specimen (see Figs. 1 and 2) which, taken on a line, gave the angler a spectacular fight.

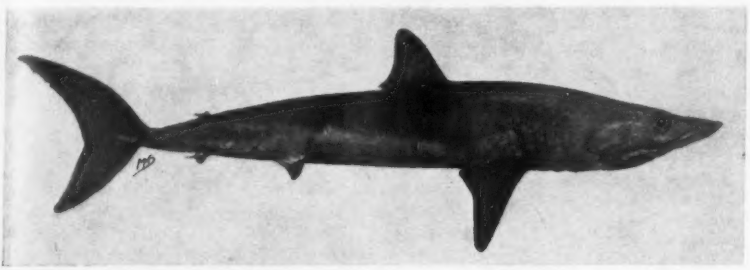

Fig. 1. *Isurus oxyrinchus* Rafinesque, 1810, ♂, 1,130 mm. total length, taken in Algoa Bay, South Africa

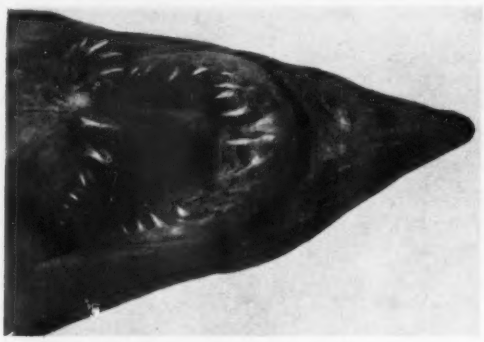

Fig. 2

The specimen is a young male, total length 1,130 mm. The following are percentages of total length: body to upper caudal pit, 80·0; depth of body at dorsal origin, 16·4; distance from snout tip to (1) first gill slit, 20·4; (2) pectoral origin, 25·6; (3) first dorsal origin, 38·0; (4) pelvic origin, 56·0; (5) second dorsal origin, 70·3; (6) anal origin, 72·2; (7) line connecting nostrils, 5·1; (8) front of mouth, 6·55. The internarial distance, 3·9; diameter of eye, 1·6; the interorbital, 6·0; width of mouth (equals height), 7·6; height of first dorsal, 8·85; its base, 8·42; distance from hind margin of eye to fourth gill slit, 17·5.

There are thirteen teeth on each side of each jaw, the third upper smaller, the front two on each side longer and more slender than all others. The body is coloured steel-blue above, white below. Weight 25 lb.

From information since received, it seems that this species may be not uncommon in South African waters.

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Effect of Galvanized Iron on Some Tree Seedlings

IT has become usual in Australian forest nurseries to grow tree seedlings in lacquered tin-plate tubes about 6 in. high and 1–1½ in. diameter, which contain sufficient soil for up to two seasons' growth before final planting. A shortage of tin-plate over recent years caused a change to the cheaper and more readily available galvanized iron.

Most varieties appeared unaffected by the change, but some species showed a yellowing of the foliage, stunting of growth and in some cases the death of the seedling after six months or more. Typical species affected are *Acacia spectabilis*, *Callitris cupressiformis*, *Casuarina suberosa*, *Eucalyptus grandis* and *Melaleuca hypericifolia*. For affected species, root growth was normal until the roots reached the tube, when further growth ceased, followed by progressive dying back of the roots until only those running straight downwards remained alive. A similar, but slower, process was seen with the roots of species which appear unaffected above ground, such as *Acacia decurrens*, *Casuarina cunninghamii*, *Eucalyptus saligna*, *Melaleuca bracteata* and *Tristania conferta*. Affected seedlings transplanted in time may recover, and there is some evidence that excessive watering may aggravate the trouble. Rusty tin-plate tubes or uncoated steel tubes, whether rusty or not, are satisfactory.

There have been reports that soils with high zinc contents have given rise to a similar chlorosis with other plants; zinc absorbed by the plant fixes available iron in the tissues so that it is no longer available for biochemical processes. A similar mechanism probably holds for chlorosis in galvanized iron seedling tubes.

In view of the convenience of galvanized sheet or wire as plant containers or protectors, this adverse effect is not so well known as it should be, particularly as there may be some effect not visible above ground. It has also been found that to dip the tubes in bitumen, as a convenient way of covering the zinc, is likely to kill the seedlings in tubes so treated. Experiments being carried out will be published elsewhere later.

We acknowledge the assistance of officers of the New South Wales Forestry Department in providing information and of Mr. E. J. Mansfield in particular, who directed attention to the effect.

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Effects of DDT and BHC on Soil Arthropods

Undesirable changes in the composition of animal communities after applications of insecticides have become increasingly common phenomena since the widespread use of the more persistent chlorinated hydrocarbons[1]. With the view of throwing further light on this problem, the insecticidal treatment of soil was considered to be a convenient experimental technique, as special attention could be paid to the effects of the insecticides on the dominant soil arthropods, namely, Collembola and Acari.

Replicated plots were treated with (1) 2 oz. per sq. yd. of 2 per cent DDT (75–80 per cent p,p' isomer); (2) 2 oz. per sq. yd. of 2 per cent BHC (13 per cent γ isomer); and (3) a combination of these. The insecticides were incorporated to a depth of 9 in., and after treatment the plots were resown with perennial rye grass (*L. perenne*). Samples were taken periodically to a depth of 6 in. and the arthropods extracted with an apparatus similar to that described by Salt and Hollick[2].

The census of total Collembola taken seven months after treatment is of special interest. Treatment totals and the standard error of their differences (all expressed as a percentage of the control population) were :

DDT	BHC	DDT plus BHC	0	S.E.*
118	76·1	106	100	6·38

* 9 d.f.; $t = 2{\cdot}26$, $p = 0{\cdot}05$; $t = 3{\cdot}25$, $p = 0{\cdot}01$

A significant increase and a significant decrease in the population of Collembola occurred in the plots treated with DDT and BHC, respectively. The population of the plots receiving both insecticides, however, did not differ significantly from that of the control, but was significantly higher than the population of the plots receiving BHC alone.

In previous investigations, phenomena of this kind have been explained on the basis of predator – prey interaction, and it is probable that the latter may provide an explanation for the results of the present investigation. On the other hand, the results may be wholly or partly explained by the reduction of competition for a common food supply. More conclusive evidence on these points is being sought, and it is hoped to publish a detailed account of the investigation in the near future.

It was also noted that in two of the plots treated with DDT the dominant species included *Tullbergia crassicuspis* Gisin, a species hitherto unrecorded for Britain.

The advice given by Dr. D. S. MacLagan and Mr. M. V. Brian is gratefully acknowledged, and thanks are also due to Miss T. Clay, who identified *T. crassicuspis*.

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Investigation of Nuclear Motion by Electron Diffraction

It has long been known that the amplitude of nuclear vibrations in free molecules could be studied by electron diffraction if sufficiently accurate intensity measurements were made. Several years ago, Karle and Karle[1] developed the first successful experimental procedure for investigating nuclear motion. Since that time results for a number of molecules have been obtained, both by the Karles and by this laboratory. It is hoped that such information will prove useful in studies of potential fields of molecules, and will also serve to help in the interpretation of diffraction patterns of more complicated molecules with similar interatomic linkages.

In a recent communication in *Nature*, Schomaker and Glauber[2] discussed for the first time the effect of the variation with scattering angle of the phase shift of electron waves scattered by atoms. In particular, they showed that conventional procedures which neglect phase shift on scattering in the interpretation of electron diffraction data may incorrectly deduce an unsymmetrical structure for a symmetrical gas molecule containing a heavy atom.

We should like to point out that atomic phase shifts must be taken into consideration in the calculation of vibrational amplitudes also, even for light atoms. No values in the literature are corrected for this source of error. According to Schomaker and Glauber, the effect upon the molecular intensity is a factor of the form $\cos s\delta$, where $s\delta = |\eta_i(\vartheta) - \eta_j(\vartheta)|$, the phase difference introduced by the scattering processes at the atoms i and j.

We note that, if the atoms are light, that is, if δ is small, Fourier analysis of the molecular diffraction terms for non-rigid molecules including the phase shift factor,

$$|f_i(\vartheta)|\ |f_j(\vartheta)|\cos s\delta \int_0^\infty P_{ij}(r)\ \frac{\sin sr}{sr}\ \mathrm{d}r,$$

will lead to an apparent distribution function of the form $\exp\{-(r-r_e)^2/2(\overline{l^2}_{ij}+\delta^2)\}$ for the separation of nuclei i and j, rather than the true $P_{ij}(r)$ of the form $\exp\{-(r-r_e)^2/2\ \overline{l^2}_{ij}\}$. The real vibrational amplitude $(\overline{l^2}_{ij})^{1/2}$ can be obtained from the apparent amplitude $(\overline{l^2}_{ij}+\delta^2)^{1/2}$ if δ is known. Schomaker and Glauber considered the case for $s\delta$ larger than $\pi/2$, in which the apparent distribution splits into two peaks separated by 2δ.

The atomic pairs treated by Schomaker and Glauber each contain a fairly heavy atom, and for these pairs δ is approximately equal to $1{\cdot}8 \times 10^{-3}\ \Delta Z_{ij}$ for 40-kV. electrons. A rough calculation for argon at this laboratory indicates that the formula $\eta(\vartheta)/s \sim 2 \times 10^{-3} Z$ also holds for lighter atoms. If only small

differences in atomic number are involved, the apparent amplitude of motion has a relative error of $\sim 2 \times 10^{-6}\, \Delta Z^2 \overline{l^2}_{ij}$. We find then, for example, that the error for a C—F bond is negligible, and the error for a C—Cl bond is about 10 per cent. If ΔZ is much greater than 10, any information about the associated interatomic spacing which is derived from the shape of the distribution function (such as amplitudes of vibration or restricted rotation or, in extreme cases, type of symmetry) must be regarded with caution unless careful corrections have been made.

Further details and experimental results will be published later.

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Difference between the Density Distribution of Neutrons and Protons in Atomic Nuclei

In a former communication[1] I calculated the energy and distribution of nucleon density of atomic nuclei by Ritz's method in the first approximation, assuming Yukawa forces between the nucleons. In the energy expression of the nucleus, in addition to the exchange energy and kinetic zero-point Fermi energy of the nucleons, we have also taken into account the kinetic energy correction of Weizsäcker, the electrostatic Coulomb energy of protons and the Coulomb exchange energy of protons arising from the Coulomb interaction of protons. In the first approximation for the neutron density ϱ_n and the proton density ϱ_p, functions of Gaussian type have been set up in the following form:

$$\varrho_n(r) = \varrho_{n_0} \exp(-a^2 r^2/r_0^2), \quad (1)$$

$$\varrho_p(r) = \varrho_{p_0} \exp(-a^2 r^2/r_0^2), \quad (2)$$

where r is the distance from the centre of the nucleus, r_0 is the Compton wave-length of the π-mesons divided by 2π, ϱ_{n_0} and ϱ_{p_0} are normalizing factors and a denotes a variational parameter to be determined from the minimization of the energy.

As a second approximation of Ritz's method, the expressions (1) and (2) have been multiplied by the factor $1 + b(r/r_0)^2$, where b denotes a further variational parameter. By varying the two parameters a and b independently of each other, the energy and the density distribution of the nucleons have been calculated in the second approximation. Thus we have obtained a small energy gain increasing with the mass number, which, however, even for the heaviest nuclei, is smaller than $\frac{1}{2}$ per cent. The change in the nucleon density is also very slight, and except for the outermost boundary areas of the nucleus, only amounts to a few per cent. Thus, in the second approximation the density distribution practically remains a function of the Gaussian type for the heaviest nuclei also. In almost all work on this subject a Gaussian density distribution has been assumed for light nuclei only; for heavy nuclei, however, in the inner parts of the nucleus a constant nucleon density has been assumed, which rapidly decreases on the boundary of the nucleus. Although our variational densities in the second approximation are sufficiently general to represent such a distribution, in spite of this the nucleon distribution we obtain from the minimization of the energy is a Gaussian-type function also for the heaviest nuclei.

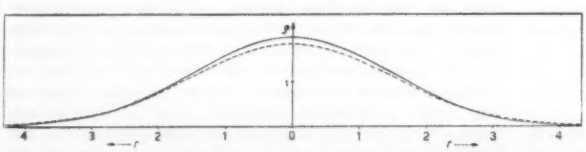

Fig. 1. Neutron density ρ_n (———) and proton density ρ_p (- - - - -) in the nucleus $A = 200$, $N = Z = A/2$. r in r_0 units, ρ_n and ρ_p in $1/r_0^3$ units

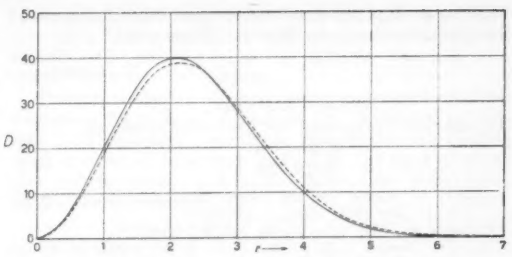

Fig. 2. Radial neutron density D_n (———) and radial proton density D_p (- - - - -) in the nucleus $A = 200$, $N = Z = A/2$. r in r_0 units, D_n and D_p in $1/r_0$ units

In all these calculations the variations of the neutron and proton density have not been carried out independently of each other. Except for the normalization factors, which are in general different, both density functions have been assumed to be equal, both of them containing the same variational parameters. As the next step of Ritz's method, both the neutron and proton density have been varied independently of each other. Thus we have obtained a further slight energy gain increasing with the mass number, and being also for the heaviest nuclei smaller than 1 per cent. Between the neutron and proton density a comparatively small difference results. As was to be expected, due to the Coulomb repulsion, the protons are pushed somewhat towards the boundary of the nucleus. The curves of the neutron and proton density, as well as those of the radial densities $D_n = 4\pi r^2 \varrho_n$ and $D_p = 4\pi r^2 \varrho_p$, are represented in Figs. 1 and 2 respectively, the difference between the two density functions being more distinctly shown in the latter. As can be seen in Fig. 1, the density functions are still of the Gaussian type. Accordingly, nothing suggests in our case the tendency to form a hole in the centre of the nucleus, resulting from the Coulomb repulsion of protons, as found by Feenberg[2].

The density distributions of the nucleons determined in this way can be used to calculate various nuclear properties and constants. Thus they have been applied to calculate the angular momentum distribution of nucleons. We have obtained for the neutron and proton numbers, at which an s-, p-, d-, f-, g-, h-, i-, . . . neutron or proton appears in the nucleus for the first time: 1, 2, 8, 20, 42, 74, 119, ... These numbers are in good agreement with the corresponding neutron and proton numbers 1, 3, 9, 21, 41, 71, 113, . . . obtained from the wave-mechanical shell model[3].

A more detailed account of these calculations will be given in the *Acta Physica Hungarica*.

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Wave Hypothesis of Moving Irregularities in the Ionosphere

The existence of moving irregularities in ionospheric regions has been demonstrated by a number of workers using a wide variety of radio techniques[1], and information regarding their properties is accumulating rapidly. The motions are frequently described in terms of 'winds'; but, as has been repeatedly stressed, the observations need not imply any large-scale movement of the atmosphere. Indeed a number of fairly general considerations can be advanced in support of an alternative view, that a propagated wave-like disturbance is the cause. At the suggestion of Mr. J. A. Ratcliffe, I have begun a theoretical examination of the magneto-hydrodynamic effects involved in such an interpretation.

It is found that travelling atmospheric disturbances, governed by pressure oscillations and gravitational forces, will be accompanied by electromagnetic oscillations which can, under special resonant conditions, become large. The corresponding amplification of the associated electron motions would render such disturbances particularly susceptible to detection by radio methods. Gravity tends to confine the movement of these disturbances to the horizontal plane, though a vertical component is introduced by the effects of cross-conductivities and temperature inhomogeneities. If these, and similar complications, are neglected, it is found that conditions are particularly favourable for disturbances of quasi-period

$$\tau \sim 2\pi \sqrt{2/\gamma(\gamma - 1)}\, C/g, \qquad (1)$$

and group speed

$$V_G \sim C \sqrt{(\gamma - 1)/2\gamma}, \qquad (2)$$

in which γ is the ratio of specific heats, C the speed of sound, and g the acceleration due to gravity. No preferred directions of travel relative to the earth's magnetic field appear at this stage, but they can be introduced, in some circumstances, by taking detailed account of electron motions and cross-conductivity effects.

It is natural to associate these resonant oscillations with the large-scale F_2-region disturbances observed by Munro[2], in which the numerical density of electrons may change by as much as 25 per cent. They appear to have a fundamental motion in the horizontal plane, with a secondary vertical component superimposed, in agreement with the theoretical predictions. Again, the larger amplitudes and shorter fractional durations (relative to τ), associated by Munro with longer periods, receive plausible explanation in terms of varying resonance conditions.

If typical values for these disturbances, say, $\tau \sim 25$ min. and $V_G \sim 7$ km./min., are inserted directly in (1) and (2), the estimates $\gamma \sim 1{\cdot}1$ and $C \sim 35$ km./min. result. The corresponding temperature ($\sim 1{,}000°$ K.) is in good agreement with other estimates for this region, but the specific heat ratio is appreciably lower than one would expect from the usual considerations. Martyn[3], however, was led to a similar result when considering the bounding of ionospheric disturbances, and he pointed out that low values of γ might well occur in regions where ionization was taking place. In any event, (1) and (2) do not take into account a number of factors which will be operative in practice, and so should only be considered as order-of-magnitude relations; as such, they appear to be quite satisfactory.

Favourable conditions are also obtained when

$$\tau \sim 2\pi \sqrt{2/\gamma}\, C/g, \quad V_G \sim C/\sqrt{2\gamma}, \qquad (3)$$

but these values do not appear to correspond to any disturbances so far reported.

No detailed analysis of the higher-frequency radio-star and E-region fluctuations has been undertaken as yet; but they appear amenable to a wave interpretation, and many of their properties can be profitably discussed on this basis.

In view of its potentialities and initial successes, the wave hypothesis might well be kept in mind when further analyses of the experimental data are undertaken.

This investigation, which is continuing, is supported by the National Research Council of Canada through a special scholarship. Full details are to be published at a later date.

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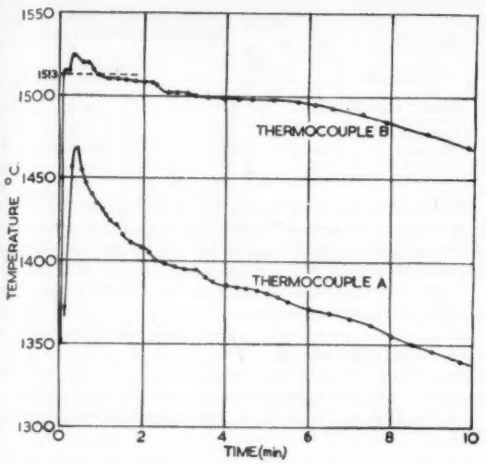
Measurement of Temperatures of Metal/Mould Interfaces

Many workers have attempted to observe metal/mould interface temperatures in metal castings by means of thermocouples with sheathed hot-junctions. However, since the temperature gradient in the refractory sheath is high, such measurements are liable to considerable error. We have therefore made measurements on an experimental steel casting with an unsheathed platinum / platinum - 13 per cent rhodium hot junction, the metal of the casting being used as intermediate metal; the two wires were simply pushed through the mould wall some 0·3 cm. apart. The technique has the following advantages: (i) it eliminates errors due to the temperature gradient across the sheath; (ii) it minimizes thermal lag; (iii) it ensures accurate location of the hot junction at the metal/mould interface, since the hot junction is formed at the points where the molten metal comes into contact with the thermocouple wires.



The temperatures recorded at the interface in the base of a 280-lb. low-carbon steel casting during the first 10 min. after pouring are shown in the accompanying graph, where the 'intermediate metal' thermocouple (*B*) is compared with a conventional thermocouple (*A*) of which the sheathed butt-welded hot junction lay in the plane of the metal/mould interface. The metal liquidus temperature of 1,513° C., shown on the graph, was determined in an independent laboratory experiment. The comparison shows that the initial chilling and subsequent remelting of the first metal to be poured are clearly recorded by *B*, but not recorded at all by *A*, owing to the temperature gradient in its sheath and its marked thermal lag. Also the temperatures recorded by *A* throughout are much lower than those of *B* because of the temperature-gradient error. Calibration of *B* before and after the experiment showed that errors due to contamination were negligible.

The method may have wider application than the one described. A detailed account of the use of the thermocouple will be published elsewhere.

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Nov. 11.

Oat Lipase and Tributyrin

Oat lipase is located in the outer pericarp layers of the groat and can be removed by wet-brushing[1]. Using this technique with 20 gm. of groats per 100 ml. distilled water, a suspension is obtained which contains *c.* 98 per cent of the total active lipase. From such extracts oat lipase has been purified approximately 1,700-fold on a dry weight basis compared with the original activity in oatmeal.

The lipase activity has been measured by two methods: (*a*) a 'dough' method using olive oil as substrate[2]; (*b*) a manometric method[3] using tributyrin as substrate in a bicarbonate – carbon dioxide buffer system at *p*H 7·4. Although the substrates are not interchangeable, that is, the lipase will not hydrolyse tributyrin in the 'dough' method nor olive oil in the manometric method, the same enzyme is thought to be responsible for both activities, since the ratio of the activities against the two substrates remains the same during the various stages in the purification of the enzyme.

The difficulties of differentiating lipase and esterase activities have been discussed by Desnuelle *et al.*[4], and it is generally considered that tributyrin hydrolysis is effected by a true lipase; in the case of milk, the tributyrinase and lipase activities have been definitely correlated[5].

In the course of a study of the kinetics of the purified enzyme using the manometric method with tributyrin at low substrate concentrations and *p*H 7·4, the reaction was observed to cease when only a third of the total possible carbon dioxide had been evolved. This suggested that the purified lipase was only splitting off one butyric acid radical, leaving a dibutyrin as a reaction product. Krebs's pots were set up and the product of reaction (*X*) was isolated as a faintly yellow oil, boiling point 185–7°/26 mm., giving a negative periodate-fuchsin reaction; analysis gave C 56·71 per cent, H 8·52 per cent and saponification value 478 (calculated for dibutyrin, 56·86 per cent, 8·68 per cent and 483, respectively).

This suggests that the hydrolysis of the triglyceride by the purified lipase involves the splitting off of only one fatty acid radical and not a complete hydrolysis to glycerol and free fatty acid. Further evidence supporting this interpretation of the mode of action has been obtained by testing the activity of the purified lipase against the other compounds of glycerol and butyric acid. α-Monobutyrin was prepared by the method of Schuette and Hale[6], β-monobutyrin by the method of Daubert[7], and the two dibutyrins were prepared from the corresponding dibromhydrins by heating in sealed tubes with sodium *n*-butyrate as described by Guth[8]. The accompanying table gives the analytical data for these compounds.

These four compounds, together with *X* and tributyrin, were set up at 37° in manometers against a freshly prepared, purified lipase (3·3 mgm. substrate per flask, 0·0148 *M* sodium bicarbonate *p*H 7·4, total vol. 3 ml., gas phase 5 per cent carbon dioxide/95 per cent nitrogen) together with appropriate boiled enzyme blanks. Lipolysis was only observed with tributyrin, the reaction being complete after 45 min. when one-third of the total possible carbon dioxide had been evolved. Thus under these conditions lipase is unable to hydrolyse either the di- or mono-butyrins, and attacks tributyrin by removing one fatty acid chain only. From the boiling point of *X* it would appear probable that the β-linkage is the one specifically hydrolysed and that *X* is in fact αγ-dibutyrin.

A high production of diglyceride has been observed with certain preparations of pancreatic lipase[4,9], and Frazer (see ref. 9) has suggested that more than one enzyme may be involved in the complete hydrolysis of a triglyceride. This, however, appears to be the first direct demonstration, with a lipase preparation acting upon a triglyceride, that only one fatty acid radical is specifically split off.

	Boiling point	% Carbon		% Hydrogen		Sap. value	
		Found	Calc.	Found	Calc.	Found	Calc.
α-Monobutyrin	140–2°/5 mm.	51·46	51·83	8·87	8·70	349	346
β-Monobutyrin	141–3°/5 mm.	51·71	51·83	8·73	8·70	343	346
αβ-Dibutyrin	169–72°/20 mm.	56·78	56·86	8·73	8·68	481	483
αγ-Dibutyrin	177–9°/20 mm.	56·88	56·86	8·76	8·68	479	483

Full details of this work will be published elsewhere.

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A New Spraying Agent for Paper Chromatography of Carbohydrates and Polyols

While investigating the chromatographic separation of sugars upon filter paper impregnated with sodium borate buffer (0·05 *N* borax, *p*H 9·18) it was found that the carbohydrates showed up prominently on spraying with 80 per cent aqueous ethanol containing either 1 mgm./ml. of phenolphthalein or phenol red just made alkaline with sodium hydroxide. Phenolphthalein gave rise to white spots on a purple background and was rather more effective than phenol red, which gave yellow spots on a purple background.

It was considered that the change in *p*H consequent upon the formation of carbohydrate–borate complexes might be used directly. Preliminary studies led to the development of a spraying reagent consisting of 1 part 0·05 *N* sodium borate (*p*H 9·18), 2 parts phenol red (2 mgm./ml. in ethanol made just alkaline with sodium hydroxide) and 7 parts methanol. The reagent could also be made up in ethanol. This, however, caused some precipitation of borate, which might lead to variability of performance, although the ethanolic reagent has given uniformly good results in our hands. Phenolphthalein was an inferior substitute for phenol red, as the reagent had to be adjusted to such a *p*H that it just coloured the paper. This proved awkward and, since the indicator did not always spread evenly, owing apparently to adsorption on the paper, phenolphthalein is not recommended.

Although we have experienced no trouble from this cause, it should be noted that acidic or basic substances able to move in the solvents used might interfere. These could be removed by ion exchange resins. The method has, however, proved more satisfactory than the use of ammoniacal silver nitrate. Methanolic phenol red–borate gave good definition with 25–50 μgm. dihydroxyacetone, arabinose, xylose, fructose, glucose, lactose, mannose, sucrose, maltose, cellobiose, raffinose and a number of polyols.

Ascending chromatography on Whatman No. 4 paper was carried out for 15 hr. using developing solvents similar to those described by Jeanes, Wise and Dimler[1]. The distances moved by glucose were about 9·5 cm. in solvent *B* and 4·5 cm. in solvent *F*. Typical *Rg* values are quoted in the accompanying table for some polyols.

The method may also be of value when it is necessary to determine the position of sugars by a technique that leaves them unchanged, so as to make possible leaching out the spots for micro-determinations.

$$Rg = \frac{\text{distance moved by substance}}{\text{distance moved by glucose}}$$

Solvent	*B* *n*-Butanol : pyridine : water :: 3 : 2 : 1·5	*F* *n*-Butanol : pyridine : water :: 4 : 1 : 1
Dihydroxyacetone	1·84	3·38
Glycerol	1·61	2·58
Erythritol	1·35	1·85
Mannitol	0·91	0·92
Sorbitol	0·92	0·87
i-Inositol	0·39	0·19

Reference has been made by Bradfield and Flood[2] in a communication entitled "Soluble Carbohydrates of Fruit Plants" to the use of borate buffer containing bromcresol purple for similar purposes to the above.

I acknowledge with thanks the technical assistance of Mrs. D. Goodinson.

D. J. D. Hockenhull.

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Serological Activity of Globulin Fractions of Anti-*D* Sera separated by Paper Electrophoresis

It seems that the existence of blocking, incomplete (non-blocking) and complete (saline) antibodies is generally accepted; but up to now little work has been done to widen our knowledge about serological activity of different fractions of anti-*Rh* sera containing those kinds of antibodies.

After preliminary examination of many immune sera, three anti-*D* sera were chosen. All these sera are very close to each other from the point of quantitative serological reaction, but at the same time they show marked differences in respect of the qualitative behaviour of anti-*D* antibody in carrying out various serological tests. The sera used are: No. 1286, containing blocking antibody (blocking titre 1/16, trypsin titre 1/32, albumin titre 1/16, saline titre negative, indirect *AHG* titre 1/128); No. 23530 with incomplete (non-blocking) antibody (blocking titre negative, trypsin titre 1/64, albumin titre 1/16, saline titre negative, indirect *AHG* titre 1/256); and No. 11871 with saline antibody (blocking titre negative, trypsin titre 1/64, albumin titre 1/64, saline titre 1/16, indirect *AHG* titre 1/128).

Electrophoresis on filter-paper strips (Whatman No. 2, 37 cm. × 5 cm.) was carried out to isolate α_1-, α_2-, β- and γ-globulin. The apparatus described by Flynn and de Mayo[1] was used with barbitone buffer *p*H 8·6; potential 350 V., for 3 hr., current 0·4 m.amp./cm. width.

In all experiments seven strips were used for each serum to be investigated; 0·03–0·04 ml. of serum was placed on each strip in a straight line 4 cm. long by means of a capillary glass pencil. After each run the strips, still wet, were cut into two parts and one of 37 cm. × 1·5 cm. was dried and stained with a solution of 1 per cent bromphenol blue in 95 per cent ethyl alcohol saturated with mercuric chloride. The strips were then washed in running tap water. The coloured strips were used for detecting the exact position of the different globulin fractions on the uncoloured parts of the strips. Each unstained strip was cut into fractions and the different globulins immersed in 1 ml. of saline (for each fraction) and eluted for 16 hr. at + 4° C. The filter paper was removed from the eluate by centrifugation and the eluates were examined, using blocking, trypsin, papain, albumin.

Test	No. 1286 a_1 a_2 β γ	No. 23530 a_1 a_2 β γ	No. 11871 a_1 a_2 β γ
Blocking	– – – +	– – – –	– – – –
Trypsin	– – – *v*	– – – ++	– – – *v*
Papain	– – – ++	– – – ++	– – – *v*
Albumin	– – – *w*	– – – *w*	– – – *w*
Saline	– – – –	– – – –	– – – +
Indirect *AHG*	– – – ++	– – – ++	– – – +
Titre of γ-eluate	blocking 1/2; ind. *AHG* 1/32	ind. *AHG* 1/64	saline 1/4; ind. *AHG* 1/16

All controls were normal. *v*, Visible clumps; ++, large clumps visible in microscopic field; +, smaller clumps; *w*, microscopically weak reaction; –, no agglutination

saline and indirect anti-human-globulin tests. In all experiments the same OR_1r and *Orr* normal, trypsinized and papainized red cells were used. The results are tabulated herewith.

It is obvious from these results that the blocking, incomplete (non-blocking) and complete (saline) antibodies belong to the γ-globulin fraction of anti-*D* sera. Anti-*D* activity was not found in any other fraction.

We could not confirm the observation of Cann *et al.*[2] that other globulin fractions contain also *Rh* antibodies. It seems to us that it is rather difficult to obtain a clear conclusion from the results obtained by those authors. This discrepancy between the results of Cann and co-workers and our results is probably due to the fact that a better separation of globulin fractions is possible by means of paper electrophoresis than by the electrophoresis convection method.

Serological examinations of different fractions, using different tests, show that the albumin method gives the weakest reactions, whereas the indirect anti-human-globulin test and the tests with trypsinized and papainized red cells give very clear reactions. It is to be noted that some samples of eluates from the γ-globulin fraction of serum No. 1286 show a very weak blocking effect in spite of a satisfactory titre obtained with the indirect *AHG* test.

The use of the paper electrophoresis method for investigating an anti-*D* serum is very simple and gives accurate results. The method can probably be used for immune sera which contain two or more antibodies with different serological specificity. The method is especially convenient for the examination of very rare antisera, since a quantity of about 0·25 ml. is enough to obtain an eluate with good serological activity. The main disadvantage of the paper electrophoresis method is that it is practically impossible to obtain an eluate with the same concentration of antibody as in the original sample of the serum used.

We thank Dr. J. J. van Loghem, director of the Central Laboratory for Blood Transfusion in Amsterdam, for his advice and help. One of us (B. D. J.) holds a fellowship of the World Health Organization.

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A Simple Method for the Preparation of Crystalline Potato Phosphorylase and Q-Enzyme

In the purification of potato phosphorylase[1] by ethanol precipitation[2], it has been found that conditions established for a particular variety of potato, harvested at a particular time of the year, are not generally applicable to other potatoes, even though these may contain as much enzyme. This is because the solubility of the enzyme is affected by its association with other constituents, the nature and quantity of which vary with the type of potato and the season. Since, in spite of this association, the enzyme is always able to react with its substrate, it was thought that the formation of the enzyme substrate complex might be utilized to free the enzyme from these other complexing molecules. Preliminary experiments in which the precipitation of phosphorylase was carried out in the presence of glucose-1-phosphate did not, however, show any appreciable change in the solubility of the enzyme. These experiments were not pursued further after it had been found that the presence of the co-substrate, amylose, results in a strong and selective precipitation of phosphorylase at a concentration of ethanol at which the enzyme is otherwise soluble[2], and in at least a thousandfold purification of the enzyme with respect to protein. The phosphorylase is accompanied in the precipitate by the *Q*-enzyme of the potato[3]. The enzymes are readily extracted from the precipitate and can then be precipitated from solution with ammonium sulphate in crystalline form.

The exact conditions of the preparation do not seem to be critical, and crystalline enzymes have been obtained from four varieties of potato for which the ordinary ethanol precipitation was ineffectual. The following has proved to be a convenient procedure. Freeze-dried potato juice is reconstituted with distilled water and brought at 0° to 11 per cent ethanol concentration with 50 per cent ethanol–citrate reagent[4] (0·282 ml./ml. juice). The precipitate, which contains amylose precipitant, is discarded. A suspension of wrinkled pea amylose[5] in water (0·2 gm./ml.) is boiled for about three minutes, and cooled to 0°. The supernatant liquid is poured into this suspension (2 ml. supernatant/1 ml. suspension) and the mixture brought to 11 per cent ethanol by adding 50 per cent ethanol–citrate reagent (0·094 ml./ml. mixture). After stirring for 10 min. the mixture is centrifuged and the precipitate washed five times, each time with seven times its volume of 11 per cent ethanol containing 0·01 *M*-citrate *p*H 6·0, all these operations being performed at 0°. The precipitate is then extracted twice for 15-min. periods with stirring with three times its volume of 0·05 *M*-citrate *p*H 6·0. The extract is brought to a concentration of 30 per cent w/v ammonium sulphate by adding the appropriate volume of 50 per cent w/v ammonium sulphate (ammonia to *p*H 7·0), and left 1 hr. at 0°. The precipitate, after centrifugation, is extracted with 19 per cent ammonium sulphate solution (0·2 ml./ml. of original juice), to give a solution I and a residue II. Crystalline phosphorylase is precipitated from solution I when this is brought at 0° to 25 per cent w/v ammonium sulphate. Crystalline *Q*-enzyme is obtained by dissolving residue II in 0·05 *M*-citrate *p*H 6·0 (0·2 ml./ml. of original juice) and bringing the solution to 17 per cent w/v ammonium sulphate *p*H 7. The enzymes can be recrystallized from the appropriate ammonium sulphate solutions.

The amount of amylose required per unit volume of juice (for example, 13 per cent w/v above) depends on the previous history of the amylose, and particularly on the extent to which it has retrograded during preparation. The pea amylose used was a rather insoluble alcohol-dried sample. Potato amylose and potato whole starch also adsorb the enzymes under the conditions described; but the use of whole starch is not advocated owing to the complications introduced by its content of amylopectin. A non-retrograded, undried sample of potato amylose was found to adsorb 50 per cent of the phosphorylase of the potato juice when added to the extent of only 3 per cent w/v of the juice. Moreover, the whole of the *Q*-enzyme was adsorbed by 0·15 per cent of this amylose, enabling the *Q*-enzyme to be removed from the phosphorylase at this stage if desired.

Part of the adsorbed *Q*-enzyme is firmly bound to the amylose and cannot be removed with salt solution. It can only be removed by washing the precipitate with starch solution. This suggests that there is a general attraction of the amylose chains for the *Q*-enzyme molecule (presumably through secondary valency forces) leading to a complex which is easily dissociated in salt solution, and that in addition there are a number of sites at which the full enzyme-substrate complex is formed. From these sites the enzyme can be removed only by presenting the substrate in the dissolved form.

It will be noticed that the method of preparation above resembles that used by Schwimmer and Balls[6], who obtained α-amylase from barley by adsorption of the amylase on starch grains from alcoholic solution, and by Hobson, Whelan and Peat[7], who removed *Q*-enzyme irreversibly on potato starch in the preparation of *R*-enzyme.

We wish to thank Prof. H. W. Melville and Prof. M. Stacey for their interest in this work. One of us (H. B.) is indebted to the Department of Scientific and Industrial Research for a maintenance grant.

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A Method of Embedding Brittle Specimens of Wood for Sectioning

Great difficulty was encountered in cutting sections from the brittle and often partly carbonized wooden remains found on the sites of Roman and ancient British settlements. The impact of the razor caused instantaneous fragmentation of the sections, and identification became very difficult. A simple embedding material was sought which would penetrate the specimen without difficulty, and which could be cut easily and would prevent the resulting section from crumbling.

A proprietary brand of a polyvinyl lactophenol mixture (that is, polyvinyl alcohol in lactic acid and phenol) was used at first, as it was known that this substance had proved satisfactory in the mounting of entomological specimens without the necessity of previous dehydration. The procedure adopted was as follows. Cubes of the brittle wood are cut in the usual way, with a tangential, a radial and a transverse face; they are then immersed in the polyvinyl lactophenol mixture and warmed gently for half an hour. After removal from the liquid, the cubes were allowed to drain and cool for 24 hr. (It will be found that the cubes are now darker in colour and of a rubbery consistency.) The cubes can then be sectioned with a sharp razor, and the sections mounted directly on to a slide, using the embedding agent as a mounting medium.

The resulting preparation possesses the added advantage of being 'cleared' by the polyvinyl lactophenol. The cell walls, which may be blackened and beginning to undergo carbonization, are rendered clear and translucent, enabling details of structure to be easily observed.

The method has proved to be a quick, easy and efficient one, but possesses certain aspects where care has to be taken. Due to the rubbery nature of the material, sections have to be cut with a sharp razor or else the cube will bend under the impact of the blade. Staining is somewhat difficult, because many dyes tend to diffuse from the sections into the mounting medium[1]. It has proved possible to stick the section to a slide, wash off the polyvinyl lactophenol in hot water, and then to stain, clear and mount up in canada balsam in the usual way, but this technique still requires to be perfected. Some preparations of polyvinyl lactophenol (for example, the proprietary one already mentioned) cause a slight shrinkage to the tissues on drying. Other preparations dry more slowly and so require a longer period at the second and third stages outlined above (for example, Salmon's type *M.A.*1 [2]).

Subsequent search through the literature has shown that this method is not new. Lubkin and Carsten[3] have used a polyvinyl alcohol – glycerine mixture for embedding and sectioning medical pathological material, such as heart, lungs, liver and spleen. Gray and Wess[4] advocate a polyvinyl alcohol – glycerine – lactic acid – acetone mixture for mounting entomological specimens, which has a slightly lower refractive index, but which Brown[5] claims overcomes the tendency to shrink and sets harder than other preparations. These preparations and others are being tested and may well eliminate some of the difficulties in the technique mentioned. Even with these disadvantages, the ease and quickness of embedding and mounting the material should commend itself as a useful method, especially where speed in identification of specimens is an important consideration.

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FORTHCOMING EVENTS

Wednesday, June 3—Friday, June 5

OIL AND COLOUR CHEMISTS' ASSOCIATION (at Eastbourne).—Biennial Conference.

Thursday, June 4

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. H. W. Thiele: "A Study of the Occupational Achievements of a Group of Adults Educated at certain Schools for the Blind".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Meeting to commemorate the Present-day Aspects of the Work of Sir William Ramsay.

Friday, June 5

PRESENTATION OF TECHNICAL INFORMATION, DISCUSSION GROUP (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 6 p.m.—Dr. P. M. Woodward: "Information Theory".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. M. F. Perutz: "Glaciers".

Saturday, June 6

BRITISH PSYCHOLOGICAL SOCIETY (in the Psychology Department, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. H. M. B. Hurwitz: "Frustration in Learning, an Account of some Experiments".

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. A. B. Dawson: "Methane Emission".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade B) IN MATHEMATICS, and an ASSISTANT (Grade B) IN PHYSICS—The Principal, Derby Technical College, Normanton Road, Derby (June 6).

HEAD OF THE CHEMISTRY DEPARTMENT—The Principal, North Staffordshire Technical College, Stoke-on-Trent (June 6).

LECTURER or ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, University College, Leicester (June 6).

PHYSICAL CHEMIST (with good honours degree, and thoroughly interested in the theory and experimental techniques associated with corrosion research) IN THE BOILER CORROSION RESEARCH LABORATORY, St. John's Wood, London—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting A.E.379 (June 8).

SENIOR ASSISTANT ENGINEER (turbines) for general investigations into turbine design problems including the effect of cycle conditions on performance, the preparation of specifications and the critical assessment of the technical features and performance of particular designs, IN THE GENERATION DESIGN BRANCH, Headquarters—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting T/381 (June 8).

ASSISTANT LECTURER IN THE DEPARTMENT OF AGRICULTURE (Crop Husbandry)—The Registrar, University College of Wales, Aberystwyth (June 10).

WELLCOME RESEARCH FELLOW for research in connexion with veterinary science or practice—The Scientific Director, Animal Health Trust, 232–235 Abbey House, Victoria Street, London, S.W.1 (June 10).

SENIOR LECTURER IN MECHANICAL ENGINEERING, LECTURERS (2) IN MECHANICAL ENGINEERING, a LECTURER IN PHYSICS, a LECTURER IN RADAR AND TELECOMMUNICATIONS, and DEMONSTRATORS IN MECHANICAL AND ELECTRICAL ENGINEERING, at the Royal Military College of Science, Shrivenham—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4211/53 (June 12).

DESIGN ENGINEERS to assist on design problems of control and instrumentation for new types of reactors (Ref. D.186/53A), an ENGINEER (mechanical) to work on mechanical design and specification of new types of reactors (Ref. C.252/53A), and ENGINEERS (electrical) to assist design, planning, construction of electric plant and services for large new project (Ref. D.187/53A); in the Ministry of Supply at Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (June 13).

PRINCIPAL SCIENTIFIC OFFICER (with University degree with first- or second-class honours in mathematics or physics or an equivalent qualification, and at least three years postgraduate or other approved experience in astrophysics, preferably with some experience in line intensity spectrophotometry) at the Royal Observatory, Edinburgh—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (June 15).

SHELL SCHOLARSHIPS IN CHEMICAL ENGINEERING—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (June 16).

GUIDE-LECTURERS (2) (with university honours degree; experience in lecturing or teaching essential, and a sound knowledge of French and at least one other European language desirable) at the British Museum, Bloomsbury—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 4208/53 (June 18).

LECTURER IN MATHEMATICS (with special qualifications in applied mathematics)—The Registrar, The University, Manchester 13 (June 20).

NUFFIELD FELLOWSHIPS (2) IN THE DEPARTMENT OF PHYSICS in connexion with research on the structure of crystalline proteins—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (June 20).

UNIVERSITY DEMONSTRATOR IN ORGANIC CHEMISTRY—Dr. F. B. Kipping, Chemical Laboratory, The University, Cambridge (June 20).

CHAIR OF BOTANY at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 22).

CHAIR OF CHEMISTRY in the Durham Division of the University of Durham—The Registrar, University Office, 46 North Bailey, Durham (June 22).

CHAIR OF ELECTRICAL ENGINEERING at the Imperial College of Science and Technology—The Academic Registrar, University of London. Senate House, London, W.C.1 (June 23).

ASSISTANT EXAMINERS (3) (with such training in chemistry and physics as will enable them to make tests to detect faults in paper, stationers' sundries, etc., supplied for the Public Service) IN H.M. STATIONERY OFFICE—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 205/53 (June 25).

APPLIED MATHEMATICIAN (preferably with experience in the application of statistical methods or in modern computational methods) in the National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, June 27).

RESEARCH OFFICER (with sufficient background and research experience in colorimetry and/or photometry) IN THE OPTICS SECTION of the National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, June 27).

ASSISTANT (Experimental Officer grade) IN THE PATHOLOGY DEPARTMENT, to work on selection and indexing of fruit stocks for virus infection, and assistance with experimental work on plant virus diseases—The Secretary, Scottish Horticultural Research Institute, Mylnefield, Invergowrie, Dundee (June 30).

ASSISTANT LECTURER or LECTURER (preferably with experience in cytogenetics) IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Liverpool (June 30).

ASSISTANT EDUCATIONAL PSYCHOLOGIST (woman) (with honours or research degree in psychology, and experience in teaching) to the Child Guidance Clinic and Bristol Schools—The Chief Education Officer, Council House, College Green, Bristol 1.

ASSISTANT LECTURER (with honours degree in geology, and preferably some research experience in stratigraphy and palæontology) IN GEOLOGY—The Secretary, University College, Gower Street, London, W.C.1.

ASSISTANT LECTURER (with good honours degree) IN PHYSICS—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

ASSISTANT SUPERINTENDENT (Senior Scientific Officer grade) (professional/academic qualifications and administrative ability essential; thorough knowledge of the use and testing of textile and related materials used on railways required) IN THE TEXTILES DIVISION of the Research Department, Derby—The Director of Research, Railway Executive, 222 Marylebone Road, London, N.W.1.

CURATOR (with university degree in anthropology or archæology) OF THE ZANZIBAR MUSEUM—The Director of Recruitment (Colonial Service), Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.167/1(/01.

DEMONSTRATOR IN BOTANY, and a DEMONSTRATOR IN ZOOLOGY (with good honours degree in botany, agricultural botany, or zoology) IN THE DEPARTMENT OF BIOLOGICAL SCIENCE—The Registrar, Wye College, Ashford, Kent.

LECTURER IN ELECTRICAL ENGINEERING (with honours degree in electrical engineering, and some practical experience)—The Professor of Electrical Engineering, Imperial College of Science and Technology, Exhibition Road, London, S.W.7.

LECTURER IN ELECTRICAL ENGINEERING (electronics) (with honours degree in physics or electrical engineering, and experience in airborne radio and radar systems, servomechanisms, or electronic techniques in measurement and control) to cover fundamental electronic circuits, including pulse circuits and their application to the measurement of non-electrical quantities—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks.

LECTURERS and ASSISTANT LECTURERS IN (*a*) APPLIED MECHANICS, (*b*) HEAT ENGINES, and (*c*) ENGINEERING DRAWING, IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Secretary, Royal Technical College, Glasgow.

REGIONAL TRIALS OFFICER (with degree in botany or agriculture or equivalent qualification, and practical experience in crop production) for work possibly at Newcastle—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

RESEARCH STUDENT (with some biochemical experience, and preferably with a knowledge of tissue slice techniques) IN THE CANCER RESEARCH DEPARTMENT, to work on problems concerning the mechanism of enzyme synthesis—The Secretary, London Hospital Medical College, Turner Street, London, E.1.

SCIENTIFIC OFFICER (Grade 1) and a SCIENTIFIC OFFICER (Grade 2) to work on behalf of the British Transport Commission on problems of friction and adhesion, at the Mechanical Engineering Research Organization, East Kilbride—The Director of Research, Railway Executive, 222 Marylebone Road, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report to the Boiler Availability Committee by the Burton Investigation Group on the Relationship between the Chlorine Content of the Coal Burned and the Availability of a Stoker Fired Boiler at the Burton Generating Station of the British Electricity Authority East Midlands Division. (Bulletin MC/233: Technical Paper No. 3.) Pp. 51. Second Interim Report on External Deposits and Corrosion in Boiler Plant, 1946–1951. (Bulletin MC/234.) Pp. 31. Summaries of Published Papers. (Bulletin MC/235.) Pp. 24. Bibliography of

Papers relating to the External Fouling and Corrosion of Boiler Plant, 1940–1951. (Bulletin MC/236.) Pp. 27. (London : Boiler Availability Committee, 1953.) [263

Memoirs of the Geological Survey of Great Britain. The Mesozoic Ironstones of England—The Liassic Ironstones. By T. H. Whitehead, W. Anderson, Dr. Vernon Wilson and Dr. D. A. Wray ; with Contributions on Petrography, by Dr. K. C. Dunham. Pp. viii+211+8 plates. (London : H.M. Stationery Office, 1952.) 25*s*. net. [303

Royal Institute of International Affairs. Information Papers No. 18 : World Production of Raw Materials. New and revised edition. Pp. viii+104. (London and New York : Royal Institute of International Affairs, 1953.) 7*s*. 6*d*. net. [313

Library Association : Reference and Special Libraries Section (South Eastern Group). Library Resources in the Greater London Area, No. 2 : Photographic Literature ; a Symposium. Pp. 20. (West Wickham : Miss O. T. Smith, Hon. Secretary, 230 Queensway, 1953.) 2*s*. 9*d*. ; to Members, 2*s*. [313

Lundy Field Society. Sixth Annual Report, 1952. Pp. 62+2 plates. (Exeter : L. A. Harvey, Secretary, University College, 1953.) 2*s*. 6*d*. [14

Chelsea Polytechnic. Fifty-seventh Annual Report, Session 1951–52. Pp. 32. (London : Chelsea Polytechnic, 1953.) [14

Photography and the Amateur Astronomer. By Dr. Gerald Merton. (B.A.A. Reprint No. 1.) Pp. 24+7 plates. (Hounslow : British Astronomical Association, 1953.) 1*s*. [84

The Production of Barley for Malting. (Monographs on Malt and Malt Products.) Pp. 28. (Bedford : Muntona, Ltd. ; Ipswich : Edward Fison, Ltd., 1953.) [84

Department of Scientific and Industrial Research : Food Investigation. Special Report No. 58 : Whalemeat ; Production and Preservation. By Dr. J. G. Sharp and Dr. B. B. Marsh. Pp. vi+48+4 plates. 2*s*. 6*d*. net. Special Report No. 59 : Whalemeat ; Bacteriology and Hygiene. By R. H. M. Robinson, Dr. M. Ingram, Dr. R. A. M. Case, Dr. J. G. Benstead ; with Appendix by Dr. H. E. Daniels. Pp. vi+56. 2*s*. net. (London : H.M. Stationery Office, 1953.) [84

Anti-Locust Memoir 5 : Seasonal Breeding and Migrations of the Desert Locust (*Schistocerca gregaria* Forskål) in South-Western Asia. By J. Fortescue-Foulkes. Pp. 36. (London : Anti-Locust Research Centre, c/o British Museum (Natural History), 1953.) 10*s*. [84

Transactions of the Royal Society of Edinburgh. Vol. 62, Part 2, No. 12 : The Monomyarian Condition in the Lamellibranchia. By C. M. Yonge. Pp. 443–478. (Edinburgh and London : Oliver and Boyd, Ltd., 1953.) 9*s*. [84

Thirty-second Annual Report of the E.R.A. for the period ended 31st December, 1952. Pp. 162. (Leatherhead : British Electrical and Allied Industries Research Association, 1953.) [94

Philosophical Transactions of the Royal Society of London. Series A : Mathematical and Physical Sciences. No. 903, Vol. 245 : Mass Transport in Water Waves. By M. S. Longuet-Higgins. Pp. 535–581. (London : Cambridge University Press, 1953.) 11*s*. [94

Commonwealth Bureau of Horticulture and Plantation Crops. Technical Communication No. 23 : Field Experimentation with Fruit Trees and other Perennial Plants. By S. C. Pearce. Pp. x+131. (Farnham Royal : Commonwealth Agricultural Bureaux, 1953.) 10*s*. [94

University of Cambridge. Report of the Observatories Syndicate for the Year ending 1952 September 30. Pp. 4. (Cambridge : The University, 1953.) [204

Wye College : Department of Hop Research. Annual Report, 1952. Pp. 70. (Wye : Wye College, 1953.) 4*s*. [204

British Iron and Steel Research Association. Annual Report, 1952. Pp. 128. (London : British Iron and Steel Research Association, 1953.) [204

Transactions of the Royal Society of Edinburgh. Vol. 62, Part 2, No. 11 : Serpentine Lavas—The Ankara Mélange and the Anatolian Thrust. By Sir E. B. Bailey and Prof. W. J. McCallien. Pp. 403–442+8 plates. (Edinburgh and London : Oliver and Boyd, Ltd., 1953.) 17*s*. 6*d*. [204

Other Countries

Carnegie Institution of Washington. Year Book No. 51, July 1, 1951–June 30, 1952 ; with Administrative Reports through December 12, 1952. Pp. xxxv+286. (Washington, D.C. : Carnegie Institution, 1952.) 1 dollar. [313

Ministry for Foreign Affairs of the Polish People's Republic. Documents on the Hostile Policy of the United States Government towards People's Poland. Pp. xii+246+8 plates. (Warsaw : Ministry for Foreign Affairs of the Polish People's Republic, 1953.) [14

East African Industrial Research Board. Technical Pamphlet No. 16 : Clays, Red and Black, and Nairobi Building Stone ; an Attempt to use them for the Manufacture of Bricks and Tiles. By W. Colet Birch. Pp. 22. (Nairobi : Government Printer, 1953.) 1*s*. 6*d*. [14

Smithsonian Miscellaneous Collections. Vol. 121, No. 3 : A Revision of the Colombian Species of Monnina (Polygalaceae). By Ramón Ferreyra. (Publication 4100.) Pp. v+59. (Washington, D.C. : Smithsonian Institution, 1953.) [14

Department of Transport : Meteorological Division. Summaries of Radiosonde Observations in Southern Canada, Stations South of Latitude 55° N., June 1941–December 1949. Pp. 149. (Toronto : Department of Transport, n.d.). 1 dollar. [14

United States Department of Agriculture. Farmers' Bulletin No. 1945 : The Pea Aphid on Peas and Methods for its Control. By J. E. Dudley, Jr., and T. E. Bronson. Pp. ii+13. 5 cents. Farmers' Bulletin No. 1971 : The Pea Weevil and Methods for its Control. By T. A. Brindley, J. C. Chamberlin and Ralph Schopp. Revised edition. Pp. ii+24. 15 cents. Circular No. 906 : Improvements in the Control of Ribes by Chemical and Mechanical Methods. By H. R. Offord, V. D. Moss, W. V. Benedict, H. E. Swanson and A. London. Pp. 72+9 plates. 35 cents. Technical Bulletin No. 1036 : Parasites of the Lima-Bean Pod Borer in Europe. By Henry L. Parker. Pp. 28. 15 cents. Technical Bulletin No. 1039 : Effect of Winter Cover Crops on Wireworm Injury to the Dry Lima Bean Crop. By M. W. Stone. Pp. 20. 10 cents. Technical Bulletin No. 1047 : Effect of Soil Treatments with DDT, Benzene Hexachloride and Toxaphene on Tobacco, Cotton and Cowpeas. By Norman Allen and Floyd F. Bondy, J. F. Bullock and E. E. Hall. Pp. 22. 15 cents. Technical Bulletin No. 1052 : Classification of the Orthezilidæ ; Supplement to Classification of Scale Insects of the Subfamily Orthezilinæ. By Harold Morrison. Pp. 80. 30 cents. (Washington, D.C. : Government Printing Office, 1951–1952.) [14

Bulletin of the World Health Organization. Supplement 7 : Guide for National Studies of Nursing Resources. By Margaret G. Arnstein. Pp. 36. (Geneva : World Health Organization ; London : H.M. Stationery Office, 1953.) 0.75 Swiss francs ; 1*s*. ; 20 cents. [14

Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Klasse der Wetenschappen. Jaargang 14, Nr. 12 : Het probleem der bevruchting in de loop der tijden. Door Dr. A. Schierbeek. Pp. 30. (Brussel : Koninklijke Vlaamse Academie voor Wetenschappen, 1952.) [14

Publications of the Kapteyn Astronomical Laboratory at Groningen. No. 55 : An Investigation on the Ellipsing Binaries brighter than Photographic Magnitude 8.50 at Maximum. By L. Plaut. Pp. iii+62. (Groningen : Verenogde Drukkerijen Holtsema N.V., 1953.) [14

United States Department of Agriculture. Miscellaneous Publication No. 273 : Insect Enemies of Western Forests. By E. P. Keen. Revised edition. Pp. 280. (Washington, D.C. : Government Printing Office, 1952.) 1 dollar. [14

Scientific Institutions and Scientists in Latin-America. Cuba. Vol. 1. Pp. iv+95. (Montevideo : Unesco Centro de Cooperacion Cientifica para America Latina, 1953.) [14

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Carnegie Institution of Washington Year Book No. 51.) Pp. 65–98. (Washington, D.C. : Carnegie Institution, 1952.) [14

Annals of the New York Academy of Sciences. Vol. 56, Article 2 : Comparative Conditioned Neuroses. By Edward J. Kempf and 15 other Authors. Pp. 141–379. (New York : New York Academy of Sciences, 1953.) 3.50 dollars. [14

State of California : Department of Fish and Game. Forty-second Biennial Report of the Department of Fish and Game for the Years 1950–1952. Pp. 187. (San Francisco : Department of Fish and Game, 1953.) [14

Smithsonian Miscellaneous Collections. Vol. 121, No. 1 : Geology of the San Jon Site, Eastern New Mexico. By Sheldon Judson. (Publication 4098.) Pp. v+70+5 plates. Vol. 121, No. 13 : Regarding Washington, D.C., Precipitation and Temperature, 1952 and 1953. By C. G. Abbot. (Publication 4130.) Pp. ii+7. (Washington, D.C. : Smithsonian Institution, 1953.) [14

Bulletin of the American Museum of Natural History. Vol. 100, Article 3 : Avian Systematics and Evolution in the Gulf of Guinea : the J. G. Correia Collection. By Dean Amadon. Pp. 393–452+4 plates. 1 dollar. Vol. 100, Article 4 : A Generic Revision of Flycatchers of the Tribe Muscicapini. By Charles Vaurie. Pp. 453–538. 1 dollar. (New York : American Museum of Natural History, 1953.) [14

Travaux et Mémoires du Bureau International des Poids et Mesures. Publiés sous les auspices du Comité International par le directeur du Bureau. Tome 21. Pp. vii+458. (Paris : Libr. Gauthier-Villars, 1952.) [84

State of California : Department of Fish and Game, Marine Fisheries Branch. Fish Bulletin No. 86 : The Commercial Fish Catch of California for the Year 1951, with an Evaluation of the Existing Anchovy Case Pack Requirements. By the Staff of the Bureau of Marine Fisheries. Pp. 68. Fish Bulletin No. 90 : Common Marine Bivalves of California. By John E. Fitch. Pp. 102. (San Francisco : Department of Fish and Game, 1953.) [84

University of Illinois Engineering Experiment Station. Bulletin Series No. 403 : Comparative Performances of Two Warm-Air Perimeter Systems and Three Convection Systems. By Morris E. Childs, Robert W. Roose, Herbert T. Gilkey and Seichi Konzo. Pp. 55. 60 cents. Bulletin Series No. 404 : Gradually Varied Flow in Uniform Channels on Mild Slopes. By Ming Lee, Prof. Harold E. Babbitt and E. Robert Baumann. Pp. 90. 1 dollar. Bulletin Series No. 405 : Studies of Slab and Beam Highway Bridges, Part 4, Full-Scale Tests of Channel Shear Connectors and Composite T-Beams. By I. M. Viest, C. P. Siess, J. H. Appleton and N. M. Newmark. Pp. 155. 1 dollar. Circular Series No. 65 : An Electric Recording Water Meter. By John K. Tuthill. Pp. 18. 20 cents. Reprint Series No. 50 : Electro-Organic Chemical Preparations, Part 4. By Sherlock Swann, Jr. Pp. 20. 20 cents. (Urbana, Ill. : University of Illinois, 1952.) [84

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1951. Pp. 24. Department of Agriculture Bulletin No. 49 (New Series) : Investigations, 1950–1951. Pp. 154. (Kingston : Government Printer, 1952.) [84

Department of Commerce and Industries : Division of Fisheries. Twenty-second Annual Report for the Year ended December 1950. By Dr. J. M. Marchand. Pp. 171. (Sea Point, S. Africa : Division of Fisheries, 1952.) [94

United States Department of Commerce : National Bureau of Standards. Circular 536 : Radio-Frequency Power Measurements. By Ronald A. Schrack. Pp. iii+16. (Washington, D.C. : Government Printing Office, 1953.) 15 cents. [94

Sudan Government. Ministry of Agriculture : Forests Department. Report for the Period January 1950 to June 1951. Pp. 62. (Khartoum : Ministry of Agriculture, 1952.) [94

Catalogues

Reference Books and Bibliographies. (List 16.) Pp. 100. (New York : Herbert Reichner, 1953.)

'Speedivac' Physics Educational Equipment Models EQ1 and EQ2. (A.116/2.) Pp. 6. Vacuum Physics : 20 Fundamental Experiments using 'Speedivac' Educational Vacuum Equipment Models EQ1 and EQ2. Pp. 26. (London : W. Edwards and Co. (London), Ltd., 1953.)

Manuscripts, Early Printed and Woodcut Books, Old Science and Medicine. (Catalogue 20.) Pp. 68. (London : E. Weil, c/o National Provincial Bank, 9 Market Place, N.W.11, 1953.)

Gurr's Biological Stains and Reagents. (Price List B.) Pp. iv+34. (London : George T. Gurr, Ltd., 1953.)